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METAL TREATING

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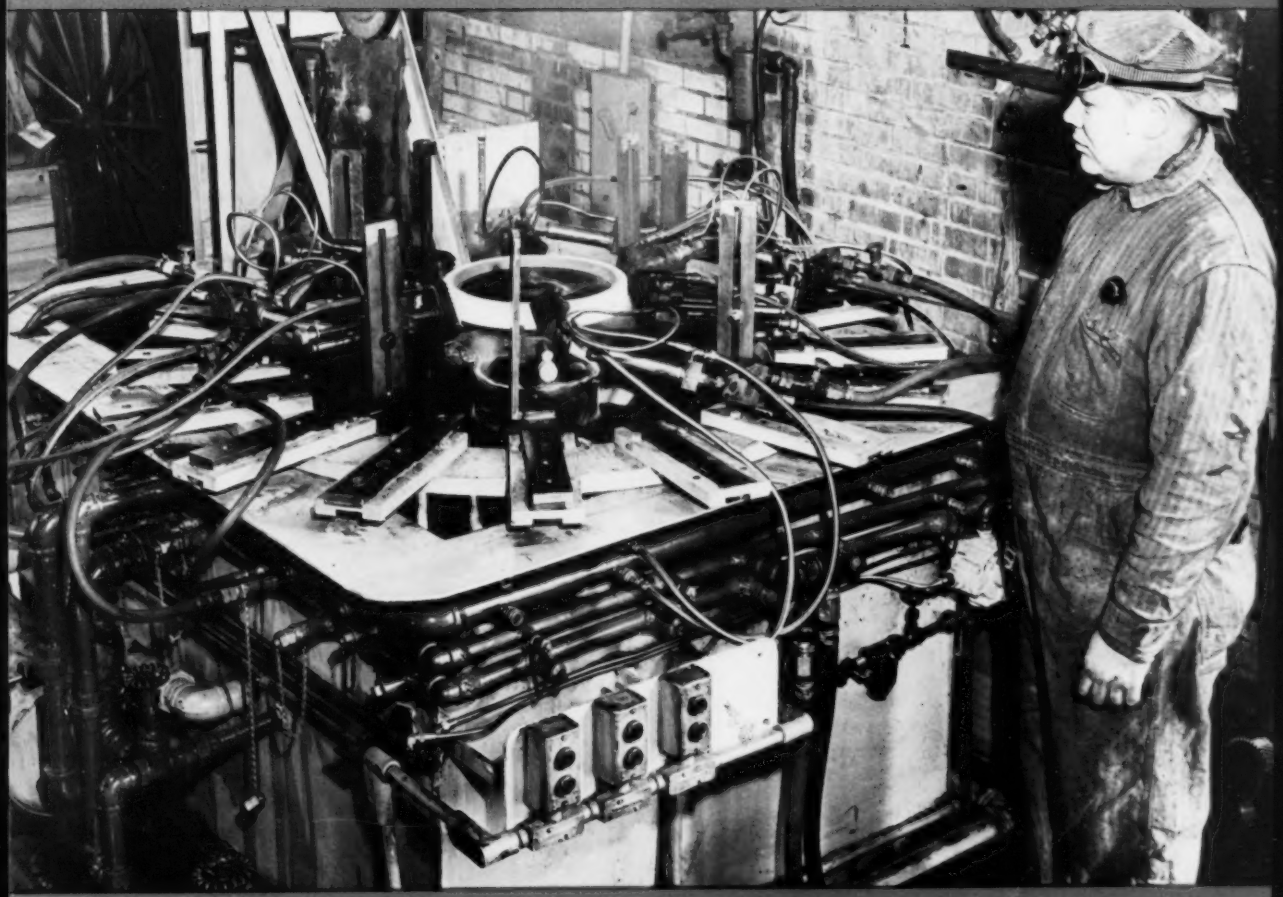
A radiant flame hardening machine designed, built and patented by Lakeside Improvement Company, Cleveland, Ohio.



THE *Only* MAGAZINE DEVOTED EXCLUSIVELY TO THE HEAT TREATING INDUSTRY

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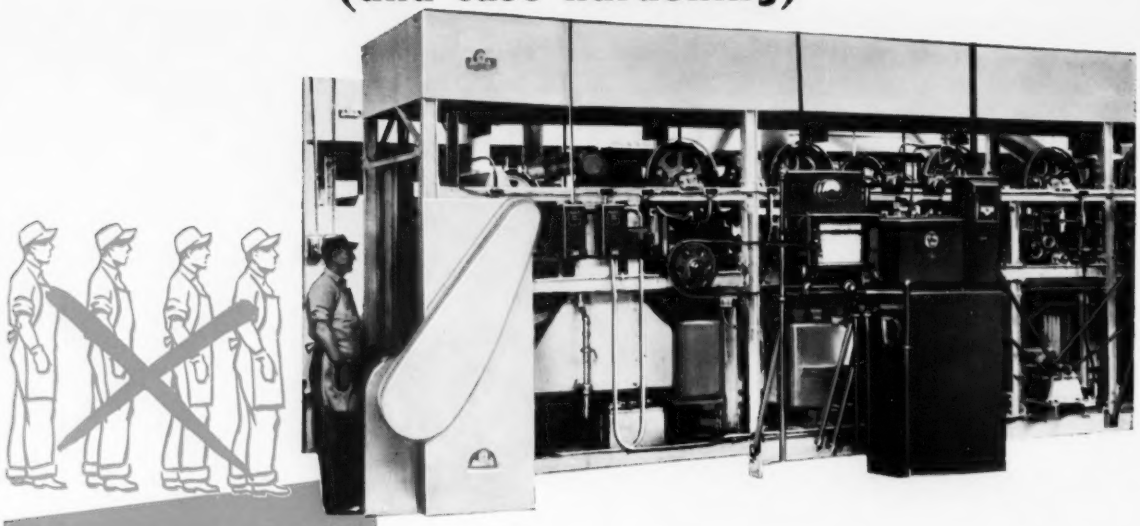

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Editorial...

A NEW AND IMPORTANT PROJECT FOR THE HEAT TREATING INDUSTRY

On page two of this issue, METAL TREATING begins publication of a series which promises to have a far reaching effect in simplifying heat treating problems and reducing the difficulties and losses which occur in this essential and complex field. The authors of this first article entitled, "Unfavorable Heat Treating Results—Their Causes and Prevention," have undertaken the ambitious task of compiling a list of troubles which occur in heat treating practice and classifying them on a scientific basis.

This work may be likened to the scientific listing by the medical profession of various human ailments, case histories and means of prevention or cure.

Such a large project, the authors recognize, must depend for success upon the active cooperation of many experienced heat treaters and metallurgists. It is in anticipation of this cooperation that METAL TREATING opens its pages to this work and invites all those concerned with the heat treatment of metals in every field to contribute documentary material, including photographs, drawings or sketches, which may be helpful in building this compendium.

This project, once well started, will continue through the years, growing more valuable as the information is collected, digested and made available in classified form to the workers in the art of heat treating. Presumably it may develop into a form of handbook or atlas supplemented by charts and tables. Dr. Balicki, Professor of Metallurgical Engineering, Polytechnic Institute of Brooklyn, offers his continued cooperation. Committees may also be established by the Metal Treating Institute and other interested technical groups for the purpose of cooperating in this project. The present article is a starting point intended to focus thinking, stimulate discussion and invite contributions of pertinent material.

METAL TREATING

Official Journal of the Metal Treating Institute

National Trade Association of Commercial Heat Treaters

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Unsatisfactory Heat Treating Results

Their Causes and Prevention

By M. Balicki
Professor of Metallurgical Engineering
Polytechnic Institute of Brooklyn
and A. O. Moelk
Graduate of Metallurgical Engineering
Polytechnic Institute of Brooklyn

Editor's Note: This article is the first in a series which it is expected will result in a compilation of material of great value to the heat treating industry. For the completion of this project it will be necessary to obtain data from every field concerned with the heat treatment of metals. The purposes and scope of this project are discussed in the editorial column of this issue.

The heat treatment of metals is an ancient art, once dependent upon the skill, experience and good fortune of the blacksmith. He had very little scientific information to guide him.

Art and skill on the part of the trained heat treater will always be essential, but today, heat treating practices are based on scientific knowledge. Recent years have yielded an enormous amount of technical information on the character and properties of metals and their countless alloys. Highly developed testing techniques have also been evolved for quality control.

But those responsible for heat treating operations are still faced with uncertainties from various quarters. Unsatisfactory results sometimes occur, although among "professional" heat treaters, these are surprisingly rare.†

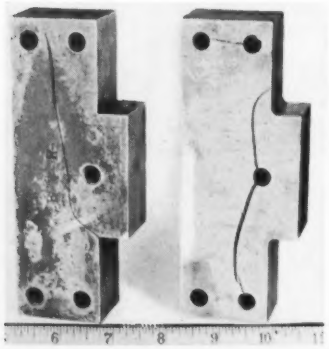
One purpose of this article is to list and classify such unsatisfactory results. This being done, the next logical step will be to identify those causes which are chiefly responsible for these conditions, and so learn to avoid them. Such a classification system should be scientifically set up and good enough to cover the *entire* field of metal treating.

Part shown before heat treatment. Saw cuts, tool marks, etc., would undoubtedly result in cracking after hardening. The causes of unsatisfactory heat treating results shown here would be classified as CG3, CG5, CG9.

Shown on these pages are the classifications which have thus far been proposed. They will be illustrated, revised and enlarged upon as more data are accumulated.

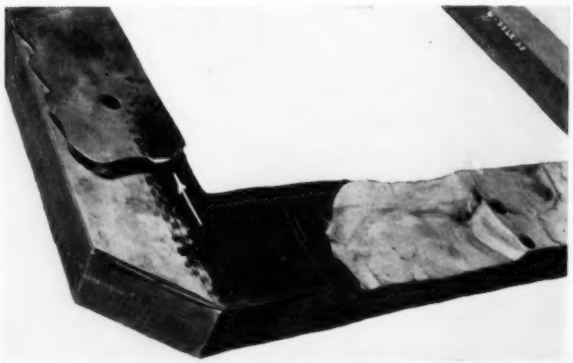
In order to avoid any misunderstanding in describing a particular fault or condition, a table of tentative definitions has been included, to cover most of the terms used in this work, as follows:

† *Ed.—A survey of the members of the Metal Treating Institute shows losses in heat treatment average only a fraction of one per cent.*



These dies illustrate effects of design in heat treatment. Cracking resulted from lack of fillets (left) and holes (right). Dies were not tempered after quenching. Under classification system, results are listed as DA4 and DA5; causes are CG3, CG9 and CF7.

Photo courtesy Bethlehem Steel Company.



This 30" Section Die, 2" thick cracked and spalled during grinding as a result of either improper grinding or heat treatment. Results are DA5 and DB1, causes are CC1, CC4 or internal stresses caused by the grinding operation which have not yet been classified.

DEFINITIONS

Apparent Defect:	An imperfection in a part which reduces its suitability or performance, easily observed with or without relatively simple apparatus.
Hidden Defect:	Imperfections detectable with only special equipment, tests or treatments.
Crack:	A discontinuity in a part which does not separate it into fragments.
Inconspicuous Crack:	A crack less than 0.003" wide.
Large Crack:	A crack greater than 0.003" wide.
Multiple Cracks:	A system of cracks which do not cross each other.
Network of Cracks:	A system of cracks in which some cross one another.
Disintegration:	Separation into two or more fragments.
Spalling:	Splitting characterized by having its start and end on the same geometrical surface and by the fact that parting plane does not intersect the axes of symmetry.
Splitting in Two Pieces:	Disintegration into two pieces in which parting lines usually transverse more than one face and intersect an axis of symmetry.
Distortion:	Any change in geometrical appearance or dimensions.
Size Distortion:	A change in dimension without change in surface curvature or angles between surfaces.
Geometrical Form Distortion:	A change in shape involving change in the radius of curvature in any one face composing the surfaces of the part, and/or change in the angles between them.
Warpage (Twist Distortion):	Deformation in which a plane face changes into a space surface of complex curvature.
Bending:	Deformation in which a flat face changes into a simple space surface.
Surface Defect:	An imperfection occurring on the surface of a part.
Scaling:	Oxidation of the surface of a part.
Decarburization:	Loss of carbon in surface layers.
Carburization:	Gain of carbon in surface layers.
Pickup of Other Elements:	Gain of an element in the surface layers of a part.
Nicks or Blemishes:	Localized damage to a surface from a variety of causes.
Pickup of Foreign Particles:	Adhesion of foreign particles to the surface of a part.
Pitting:	Indentations or cavities on the surface of a part.
Soft Spots:	Local areas on the surface or subsurface which are softer than nearby areas.
Blisters:	A locally raised surface characterized by the presence of a large crack in the subsurface zone.
Potential Defect:	Capacity for developing apparent defects on storing, in finishing operations, or in service.

CLASSIFICATION OF UNSATISFACTORY HEAT TREATING RESULTS

All Classification Numbers Are Preceded by "D" When Referred To, As DAI, DBI, etc.

A. Cracks

1. Single inconspicuous less than 0.003"
2. Multiple inconspicuous less than 0.003"
3. Network inconspicuous less than 0.003"
4. Single large larger than 0.003"
5. Multiple large larger than 0.003"
6. Network large larger than 0.003"

B. Disintegration

1. Spalling
2. Splitting
3. Distintegration into two or more fragments

C. Distortion

1. Twisting of flat surfaces
2. Bending of flat surfaces
3. Size distortion
4. Geometrical form distortion

D. Surface Defects

1. Scaling
2. Decarburization
3. Carburization
4. Pickup of foreign particles
5. Pickup of other elements
6. Pitting
7. Blisters
8. Incipient melting, burning

E. Mechanical Defects

1. Nicks
2. Scars
3. Blemishes
4. Rusting

F. Physical Properties

1. Hardness too low
2. Hardness too high
3. Tensile strength too low
4. Yield strength too low
5. Impact strength too low
6. Not locally hardened as specified
7. Hardness not uniform

G. Structure Requirements

1. Grain size too large
2. Grain size too small
3. Carbide dispersion not as specified
4. Too much retained austenite
5. Precipitated compounds not optimum size
6. Precipitated compounds not optimum dispersion
7. Crystal boundaries not as desired
8. Structure gradient not as specified (in nitriding, etc.)

H. Structure Stability

1. Tendency to develop dimension changes
2. Tendency to develop cracking
3. Tendency to change in physical properties

CLASSIFICATION OF THE CAUSES OF UNSATISFACTORY HEAT TREATING RESULTS

All Classification Numbers Are Preceded by "C" When Referred To, As CAI, CBI, etc.

A. Chemical Composition

1. Unsuitable for part
2. Low hardenability
3. Inconsistent (different heats)
4. Variation due to ingot segregation
5. Variation due to localized crystal segregation
6. Variation in banded or composite assemblies
7. Excessive non-metallic inclusions
8. Variation near surface due to loss or pickup of elements

B. Furnace Atmosphere

1. Partial instead of high vacuum
2. Decarburizing instead of neutral
3. Carburizing instead of neutral
4. Oxidizing instead of neutral
5. Reducing instead of neutral
6. Inert instead of active
7. Metal vapor present
8. Reducing instead of oxidizing

C. Method of Heating

1. Temperature too low
2. Temperature too high
3. Preheating omitted
4. Inadequate time at heat
5. Excessive time at heat
6. Poor placement of part in furnace
7. Excessive furnace loading
8. Incorrect heating program

D. Cooling and Quenching

1. Incorrect cooling rate
2. Incorrect quenching medium
3. Quench bath contaminated
4. Bath volume too small
5. Insufficient bath agitation
6. Bath temperature too high
7. Bath temperature too low
8. Transfer time to bath too long
9. Interrupted quenching time too short
10. Interrupted quenching time too long
11. Time of holding in air during interrupted quench too short
12. Time of holding in air during interrupted quench too long
13. Poor placement of part in quench bath
14. Uneven cooling due to thermal gradient in heating
15. Uneven cooling due to varying section thicknesses
16. Uneven cooling due to quenching too many parts at once
17. Uneven cooling due to lack of plugging
18. Uneven cooling due to adhesion of padding, etc.
19. Uneven cooling due to coolant vapor insulation
20. Uneven cooling due to irregularities in surface finish
21. Uneven cooling due to chilling or insulation by handling equipment or fixtures

E. Retarded Quench

1. Austempering temperature too high
2. Austempering temperature too low
3. Austempering time too short
4. Austempering time too long
5. Martempering temperature too high
6. Martempering temperature too low
7. Martempering time too short
8. Martempering time too long
9. Sub-zero cooling too rapid
10. Sub-zero cooling omitted

F. Tempering

1. Time between quench and temper too long
2. Tempering too rapid
3. Temperature too high
4. Temperature too low
5. Temperature not uniform
6. Time too short
7. Tempering omitted
8. Second temper omitted

G. Design

1. Excessive differences in section thickness
2. Re-entrant radii too small
3. Poorly designed fillet
4. Unfavorable placement of keyways
5. Unfavorable shape of keyways
6. Unfavorable symmetry (unbalanced section)
7. Section thickness too large
8. Section thickness too small
9. Holes in critical places
10. Corners too sharp

H. Previous Processing Operations

1. Surface seams
2. Laps
3. Slag stringers
4. Pressed-in scale
5. Open pipe
6. Laminations
7. Porosity
8. Blow holes not welded
9. Blisters not welded
10. Incipient cracking from forming too cold

I. Structure Characteristics Prior to Heat Treating

1. Insufficient breakdown of ingot structure
2. Poor dispersion of hardening phases (carbides, etc.)
3. Hardening phases of poor shape
4. Directional differences in structure
5. Residual effects of cold working
6. Poor degree of cold working
7. Poor surface quality
8. Previous overburning
9. Surface decarburization

J. Internal Stress

1. Varying section thicknesses
2. Varying composition
3. Difference in coefficients of expansion
4. Volume change during transformation
5. Incomplete transformation
6. Work hardening
7. Inadequate support of part in furnace
8. Inadequate support of part in quenching

Features Most Desirable in Batch Carbonitriding Equipment

By George C. McCormick & Clifton E. Wenger
Industrial Heating Equipment Co.
Detroit, Michigan

The need for carbonitriding equipment in the commercial heat treating industry is constantly increasing. The purpose of this article is to discuss some of the features which such equipment should contain: and why these are important to the commercial heat treater if he is to have in the equipment the flexibility which he needs in the great majority of cases. These features are:

1. Ability to Change Temperature Rapidly Both Upward and Downward:—For example, gas carburizing at 1700°F. for case depth followed by gas cyaniding at 1475°F. for file hard surface, 0.003" maximum depth. Another example—clean hardening at 1500°F. and next load, carburizing at 1650°F. (light case) or 1700°F. (deep case).

2. Fast Recovery Time:—Since a fan should be used to mix and force the furnace atmosphere gases through and around the work, it is logical that this fan also should contribute to the heating of the stock. By the use of a powerful fan the heating rate is increased and other desirable results are secured; namely, that of uniform heating consistent with metal thickness variation and uniform cases because of the constant sweep over the work of the active gases.

In one installation in which the features outlined above are incorporated a heating rate of 65 pounds per square foot per hour is secured against a more common 35 pounds per square foot per hour. At this installation there was no observable difference in case depth on any part of any piece taken from any position in the work box.

3. Effective Quenching:—One of the most important features in equipment of this type is an effective quench which will handle heavy loads without fire hazards, but with uniform quenching and resultant uniform hardness in both cases and core.

Since undesirable distortion will result from non-uniform heating, non-uniform quench and poor support, a powerful quench system will reduce distortion to a minimum if adequate attention is given to the matter of support and the correct furnace temperature for the steel being processed. Further, for steel of marginal hardenability, the best possible hardness will be obtained.

4. Quench-Oil Temperature Control:—Every commercial heat treater knows the importance of quench oil temperature control. Elaborate systems for such control are sometimes employed but a cooling unit balanced to the maximum heat input will achieve such control with a minimum of equipment.

5. Simplified Maintenance:—The reduction of expensive down time is most important to the commercial heat treater. Large diameter radiant tubes with special burners will provide long tube life. With these and the following objectives in mind the unit (Fig. 1) has been designed.

A specially designed fan is employed with a water cooled shaft; all alloy rollers and rails are readily removable through the furnace door with minimum disturbance of the brick work; all cylinders are mounted well away from the heat.

6. Organized Stockhandling:—The stock handling system for this furnace is arranged as to permit the movement of the work to and from the furnace without congestion. This is accomplished as follows:

a. By use of the in and out principle green stock and finished work can be stored in the areas adjacent to the furnace without hindering the movements necessary to furnace operation.

b. An electro-mechanical hoist is employed to raise the loaded boxes from the working floor to the storage station and lower the finished work from the storage station to the working floor.

c. By means of the stock transfer car work is shut-

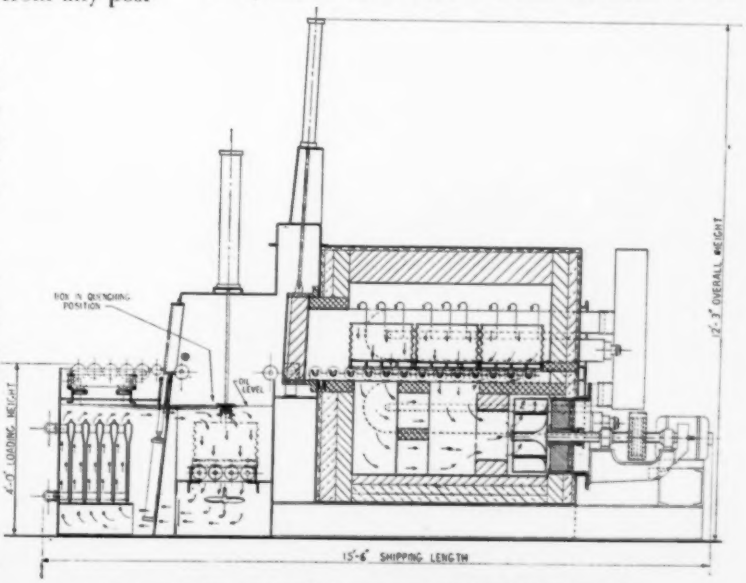


Fig. 1—A modern, packaged, floor mounted batch carbonitriding unit.

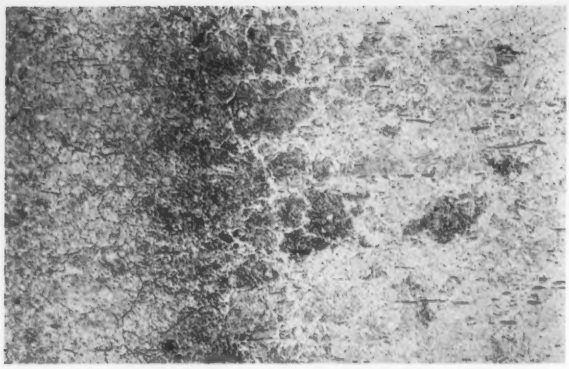


Fig. 2—Cross-section of hardened case magnified 100X. SAE 52100 steel after carburizing.

tled between the furnace and the storage station quickly and easily.

d. By the employment of roller rails in the furnace, ease in charging and discharging the work into and out of the furnace is accomplished without the need of troublesome mechanical devices which must operate at heat treating temperatures.

An example of the quality of the work that can be expected from this equipment is described in a discussion of the following test made at a commercial heat treating plant in Detroit, Michigan.

Each of three boxes contained approximately 200 pounds of bearing races made of SAE 52100 steel plus a test piece of SAE 1010, ½" diameter by 4" long. The data on the processing of each box, as determined from the recorder charts, is as follows:

All the boxes were loaded in the furnace and brought to temperature in 50 minutes. The temperature of the load was controlled between 1680°F. and 1700°F. for 9 hours and 25 minutes. The load was then cooled to 1600°F.; cooling required 20 minutes. After the load reached 1600°F. it was held for 10 minutes in a temperature range between 1610°F. and 1590°F.

No prior history had been determined for this furnace in running a .060" to .065" case depth on SAE 52100 steel so calculated cycles were used. At the end of the above carburizing cycle, Box No. 1 was quenched from 1600°F. in oil at 110°F., and held in the oil for 4 minutes. A sample race was fractured and using a Brinell glass the case depth was read as .055" to .060" depth.

The SAE 1010 carbon test bars were checked after having been run with the load of sample races as a comparative sample. It was determined that one more hour at 1680 to 1700°F. would be advantageous for Boxes 2 and 3. The time consumed in checking and rechecking the case depth on Box No. 1 was one hour. During this period the furnace containing Boxes 2 and 3 were idling between 1610 and 1590°F. At this point the furnace was turned back up to 1680 to 1700°F. range, and the time for coming up to 1700°F. was 10 minutes.

For one hour the furnace idled in a temperature range between 1700 and 1680°F. The natural gas was increased from 95 c.f.h. to 100 c.f.h. with the Endogas from the generator remaining at 400 c.f.h.

When the additional hour of processing at 1700°F. was completed the recorder was turned down to 1600°F. Twenty minutes passed in order to drop the temperature, and the stock was held for 10 minutes at a temperature range between 1590 and 1610°F.

Boxes 2 and 3 were then quenched for 4 minutes each in oil at 110°F. Brinell glass readings on fractured samples indicated .060" to .064" case depth was present.

Fig. 2 shows the metallurigcal structure of a cross-section of the hardened case magnified 100 times. Fig. 3 shows the same cross-section of the case magnified 500 times.

Fig. 3—Hardened case of SAE 52100 Steel at 500X.

In the selection of carbonitriding or carburizing equipment the commercial heat treater should look for the following characteristics:

1. Maximum overall efficiency.
2. Larger productive capacity with smaller maintenance costs.
3. Best quality for lowest investment cost.
4. Greater versatility and fewer shutdowns.
5. More desirable working conditions with less stockhandling.

Multiple Forms Provide Internal Control for Commercial Heat Treating Plant

By C. H. HEWITT, *President*
Dayton Forging & Heat Treating Co.
Dayton, Ohio

Commercial heat treating plants, unlike manufacturing companies, cannot plan on a definite schedule of production and a uniform price per piece of work turned out. Due to the variety of parts, the many possible combinations of treatments and processes, errors can easily occur unless exacting control is maintained throughout all sections of the plant. For this reason we have adopted the use of the multiple form shown in Fig. 1 which is first prepared as the work enters the plant and sections of which follow the work through the plant while others are maintained in their appropriate departments for correlation when the work is completed.

The form consist of nine sheets interleaved with one-time carbons and is made up as follows:

1. Original Invoice
2. Duplicate Invoice
3. Triplicate Invoice
4. Factory Instruction Sheet A
5. Factory Instruction Sheet B
6. Factory Instruction Sheet C
7. Factory Instruction Sheet D
8. Packing Slip
9. Delivery Receipt

The complete schedule with the use of these forms (See Fig. 2) is as follows. When material to be heat treated comes into the plant it is placed in a marked area and given the section number and corner position of that area. This identifying number is then placed on the customer's order. The heat treat checker takes the customer's order and examines it for completeness including trade name of the material or SAE Designation and all other information required. A typist then places the information on the multiple form from the customer's order: Name and address, customer's order number, customer's job number, quantity, description of pieces, general instructions, section and corner number.

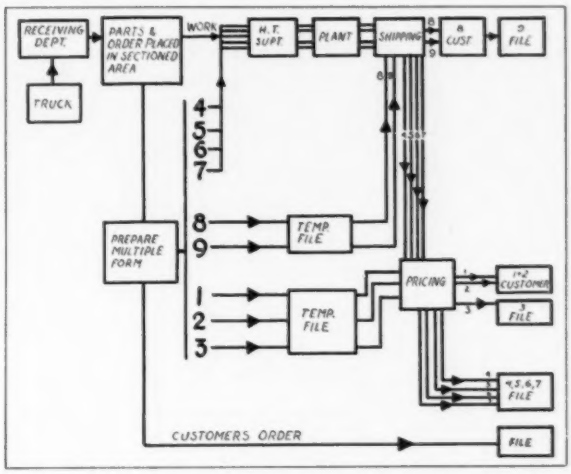


Fig. 2—Abbreviated flow diagram showing main route of multiple form.

The heat treating job number is then placed on the customer's order and the order permanently filed. The first three sheets of the form (invoices) are placed together in a temporary file pending completion of the work; the last two copies of the form (packing slip and delivery receipt) are also temporarily filed pending completion of the work.

The factory instruction copies (Nos. 4, 5, 6, 7) are placed with the customer's work and are filled in by the heat treating superintendent. He records the weight and percent of solid for pricing purposes, and inserts the necessary heat treating instructions. He also enters any other allied operations which are to be performed such as straightening, wiring, plugging, shot blasting, etc.

The heat treating superintendent then classifies the operations and designates the workers to handle the parts. The factory instruction sheets accompany the

(Continued on page 33)

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104454
THANK YOU FOR YOUR ORDER
YOU WILL ALWAYS FIND US ANXIOUS TO COOPERATE WITH YOU
MAY WE HAVE YOUR SUGGESTIONS
PACKING SLIP FROM THE DAYTON FORGING AND HEAT TREATING CO

Fig. 1—Three sheets of the nine-part multiple form. *Left*—Invoice, *Center*—Factory Instruction Sheet, *Right*—Packing slip.

A Recent Development in Measuring Flame Hardening Temperatures*

Flame hardening is a very versatile and effective method of heat treating which has found wide application throughout industry. However, despite the versatility of the method itself, the measurement of temperatures developed by flame hardening presented a number of problems which have only recently been overcome.

In either the spinning or progressive hardening method a very rapid temperature rise is encountered which cannot be easily or accurately measured by conventional means. At present, the methods used to measure these temperatures vary from trial and error to set up a definite cycling time to the use of optical pyrometers. Until the introduction of the Milliscope,** heat treaters have had to rely on some variation of conventional temperature measuring methods, none of which were designed from the standpoint of use in flame hardening.

Optical pyrometry is the only method which is capable of accurately handling the prime cause of error in measuring flame hardening temperatures, that is, the very rapid rate of increase in temperature. These instruments are considered to be of two types—one is the partial radiation pyrometer which measures only a specific wave band of radiation from a heated object; the other is the total radiation pyrometer which measures all of the radiation from a work piece. In conventional instruments, measurement of the temperature consists of comparing the work piece radiation with the radiation from a calibrated incandescent lamp. The comparison is made by eye and as such is subject to human error and a time lag is also encountered while the operator makes this comparison. In the Milliscope, however, comparison is made electronically with complete accuracy and no time lag. The instrument measures radiation in the infrared range and while not a total radiation pyrometer, it does not use the highly selective band typical of partial radiation instruments.

Description of the Milliscope

The schematic diagram (Fig. 1) shows the components of the Milliscope and a brief description of their operation is included here for interest. Useful radiation from the work piece (1) enters the Milliscope and is focused on a lead sulphide cell (10) through a rotating chopper disc (7) which is driven by the synchronous motor (8). At the same time radiation from an incandescent lamp (6) is also focused on the lead sulphide cell through the chopper disc. The arrangement is such that the lead sulphide cell receives radiation from the work piece and incandescent lamp alternately. The "temperature" of the incandescent lamp is controlled by the rheostat (3) which is set by the calibrated instrument (4).

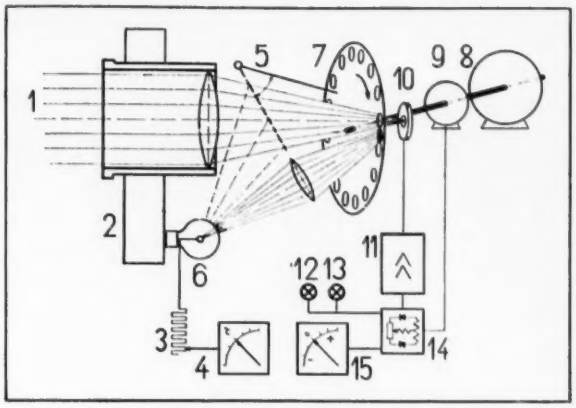


Fig. 1—Schematic diagram of Milliscope.

From this we can see that should the radiation from the work piece and incandescent lamp be the same, a direct current would result from the constant energy fed to the lead sulphide cell. If, however, the radiation from either the work piece or incandescent lamp is greater, then an alternating current would be set up by the lead sulphide cell inasmuch as there would be first a weaker, then a stronger radiation. In order to be able to tell which radiation is stronger, a zero instrument (15) sensitive to phase is used. This is accomplished through the use of an auxiliary generator (9) driven from the synchronous motor (8), a voltage amplifier (11), and a phase bridge and relay (14). Thus, when the work piece radiation is stronger, a negative value is indicated; when both radiations are equal, a zero value is indicated; and when the incandescent lamp radiation is stronger, a positive value is obtained.

A green and red pilot lamp (12 and 13) are used to give a visual signal to augment the needle indication on the zero instrument. The green lamp is lit until the temperature measured from the work piece reaches —9°F. of the desired temperature. In the

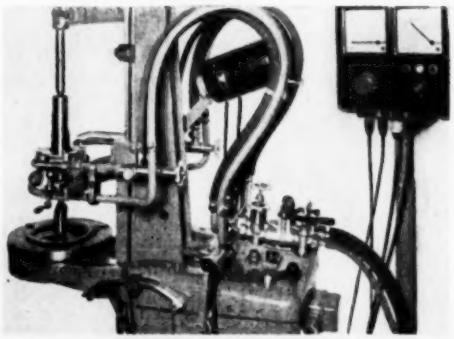


Fig. 2—Hydraulically driven vertical flame hardening machine. Milliscope controls at right. Milliscope at top center focused on work.

* An Abstract of the Article Entitled "Physical and Technical Principles of the Temperature Measuring Instrument Milliscope and Its Application," by Dr. Ing. P. Orlich, "Technische Mitteilungen," No. 8, 1952.

** Manufactured by Hartmann & Braun, Frankfurt aM, Germany. Sold through Carlingo Commodities Corp., 15 William St., New York 5, N. Y.

range of the desired temperature ±9°F. both lamps are out and when the actual temperature measured exceeds the desired temperature by 9°F. the red lamp is lit. These lamps are controlled by relays which are also connected to the switch contact of plug receptacle. This relay arrangement permits the use of almost any control device desired.

Applications

The hydraulically driven vertical hardening machine shown in Fig. 2 is a good example of how the Milliscope can be used to actuate control devices. In this setup the feed of the burner support is set by hand somewhat below the required speed so that the work piece has a tendency to overheat. When the red pilot lamp lights the relay opens a solenoid actuated valve which admits additional oil into the hydraulic cylinder. The burners then move faster until the red lamp goes out indicating that the work piece is within 9° of the desired temperature. Due to the inertia of the machine itself, the temperature will vary over a range of 18 to 27°F.

An interesting application of the Milliscope as a control device is one used on an electrical butt-welding machine. The work head of the Milliscope is located vertically above the seam of the weld and the lens is protected against sparking during the welding operation by a shield. Through an interlock system the welding can only be started when the shield is in place. The Milliscope plays no part in the actual welding operation but controls the normalizing of the weld on the same machine. After welding, the Milliscope is focused on the seam and it automatically closes a reduced welding current causing the work piece to heat up in a broad zone around the weld. As soon as the normalizing temperature is reached, the Milliscope interrupts the circuit. The temperature of the normalizing can be maintained within ±9°F.

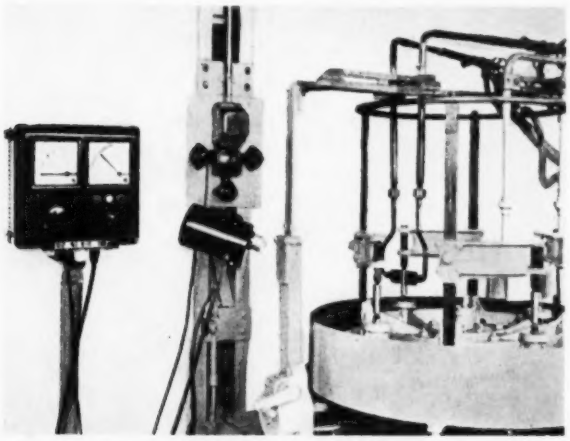


Fig. 3—An automatic bolt hardening machine with four stations for heating, quenching and removal of parts. Dial at left is temperature setting instrument; dial at right is zero instrument.

It is also possible to use a recorder in conjunction with the Milliscope when a constant temperature is desired. Fig. 3 illustrates a bolt hardening machine on which a record is made of the hardening time and temperature of each bolt. The use of the Milliscope on this machine indicated that a constant gas pressure was not being supplied to the machine. Obviously this equipment would require either a pressure regulator on the supply line or use of the Milliscope for actual control.

Fig. 4—A camshaft hardening machine with Milliscope controls mounted on control panel.

Fig. 4 illustrates the use of the instrument on a spinning hardening machine. When several varying sections are to be hardened, as in the case of the camshaft shown, the instrument is focused on the most delicate part. Fig. 5 and Fig. 6 show machines where the speed of rotation of the part being heated is controlled by the Milliscope. Caution is necessary when starting the hardening operation since an approximate speed must be set first to allow the piece to reach the desired temperature set on the Milliscope. Once at this temperature, a positive, infinitely variable speed reducer is controlled by the Milliscope through a regulating motor.

There have also been many applications of the Milliscope in heat treating practices other than flame hardening. Among these have been the measurement of stock temperature as it is removed from a furnace prior to rolling. The instrument has also proved extremely useful and valuable for measuring temperature of rolls while in operation thus permitting greater control of this temperature and increased roll life.

(Continued on page 34)

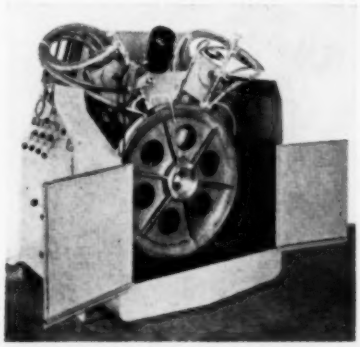


Fig. 5—Flame hardening machine for large circular parts where Milliscope controls the speed of rotation in progressive hardening.

News to Heat Treaters...

IFMA's Twenty-Third Annual Meeting

Representatives of thirty-one member companies of the Industrial Furnace Manufacturers Association met at Hot Springs, Virginia, May 17 to 20 for the Spring Meeting covering business sessions and a number of important addresses. A highlight of the meeting was an address by Brig. Gen. K. D. Metzger, Chief, Industrial Resources Division of the Air Materiel Command. Gen. Metzger presented those in attendance with a picture of the present air force production requirements.

The air force has reached, and perhaps exceeded, production capacity requirements for 143 wing strength. If any reduction in wing strength is made it is logical that a proportionate decrease in component production will result. There are no new contracts of any size to be let but neither will there be cancellation of any contracts more than 20% complete.

A very pertinent address was made by Dr. Neil Carothers, Dean Emeritus of Lehigh University on the subject of "Korea and The American Economy." He feels that even if the Korean War ceases we must continue with almost the same production rate for national security.

Technical papers were presented by Mr. Ernest A. Schoefer, Executive Vice President of the Alloy Casting Institute entitled, "Current Research on Heat Resistant Cast Alloys as Related to Nickel Conservation," (see below) and Mr. Kirtland Marsh, In Charge of Furnace Division, Mechanical Engineering Department of the Aluminum Company of America entitled, "Heat Transfer Rates to Aluminum."

Carl L. Ipsen, Executive Vice-President of IFMA stated that attendance at this Spring Meeting broke all records; a total of 123 persons were present.

Trinks Industrial Heating Awards

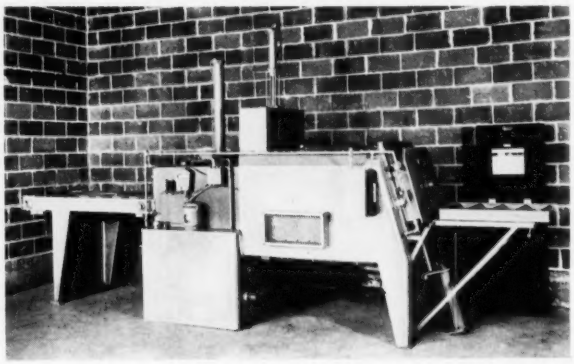
On May 5th, four engineers received the Trinks Industrial Heating Award for the most notable contributions to the economic and scientific progress of industrial heating during the past year. The men honored, all industrial executives, were: Harry H. Harris, President, General Alloys Co., Boston; Carl I. Hayes, President, C. I. Hayes, Inc., Providence, R. I.; Carl F. Mayer, President, The Carl Mayer Corp., Cleveland, and J. Spotts McDowell, Technical Assistant to the President, Harbison-Walker Refractories Co., Pittsburgh. Each received a medallion bearing the likeness of Dr. Trinks.

The award was established in honor of Dr. Willibald Trinks, Professor Emeritus of Carnegie Institute of Technology and world authority on industrial heating. Dr. Trinks first joined Carnegie Tech in 1903 and has since been active in industry as a Consulting Engineer for a number of industrial concerns as well.

Automatic Controlled Atmosphere Draw-Quench Unit

A combination draw-quench unit has been announced by Ipsen Industries, Inc. of Rockford, Illinois. The D-Q 300 furnace is designed for bright or controlled oxidation tempering from 400°F. to 1400° F. and is fully automatic. Controlled endothermic atmosphere is provided in both heating and cooling chambers which are separated by a sealed inside door.

The unit makes possible the immediate transfer of



heated work into the quench or cooling zone without furnace cooling or work handling delays. After completion of the heating cycle, the intermediate door opens automatically and chain driven rods move into the heat zone, contact the load with cam actuated arms, and transfer the trays to the quench rack. The intermediate door reseals automatically, allowing another work tray to be loaded immediately into the heat zone.

Electric heating elements are located beneath the load and an alloy fan provides for force convection. Water for controlled oxidation is admitted through a connection at the top of the furnace. Immersion heating elements and water jackets around the cooling chamber provide temperature control of the quench and cooling zones. Two two-speed motors circulate oil downward through the load in quenching. The unit is operated from a control panel and is floor mounted; requiring only service connections for complete installation.

New Barber-Colman Office

The Barber-Colman Company of Rockford, Ill., has announced the opening of a new factory branch office in Columbia, South Carolina. The new office, located at 537 Harden Street, will handle the sale of Automatic Control and Air Distribution products. Mr. Robert Lindsay is the branch manager.

Wheelco Instruments Division of Barber-Colman Company has also announced the appointment of several new service engineers and the territories they will serve. They are: James Heinlen, Cincinnati; James J. Hoffman, Jr., Cleveland; D. J. Parker, Omaha and Vernon N. Jennings, Tulsa.

(Continued on page 12)

TABLE II - PHYSICAL PROPERTIES OF HOUGHTON'S LIQUID BATHS

Type	Product	Melting Point °F.	Working Range °F.	Specific Heat (At Oper. Temp.)	Specific Gravity (At Oper. Temp.)	Unit Weight Liq. (lbs. per cu. ft.)	Liquidity (Drag-out gr. per sq. inch)
Liq. Carb.	Perliton Liq. Heat	1220	1350-1675	0.4-0.3	1.60 approx.	100 @ 1550	0.075-0.100 @ 1500 approx.
" "	" 11	1240					
" "	" 45	1210					
" "	" 60	1170	1350-1750	0.4-0.3	1.60 approx	100 @ 1550	0.075-0.100
Reheat	Perlitex 30	960	1050-1550	0.4-0.3	1.60 approx	100 @ 1400	0.017 @ 1450
"	" 50	940				95 @ 1400	0.013 @ 1450
"	" 75	1000				88 @ 1400	0.075 @ 1450
Carbonate	Liquid Heat 300	1040	1150-1700	0.442	1.90	119 @ 1500	0.025 @ 1500
Neutral	Liquid Heat N.D.	1200	1300-1700	0.171	2.65	165 @ 1550	0.075 @ 1500
"	" " 168	1240	1350-1650	0.263	1.60	100 @ 1350	0.020 @ 1500
"	" " 800	950	1025-1400	0.16	2.19	137 @ 1250	0.06 @ 1100
"	" " 980	980	1100-1650	0.158	2.24	140 @ 1250	0.04 @ 1250
"	" " 1145	1200	1300-1650	0.26	1.60	100 @ 1350	0.020 @ 1550
"	" " 1185	980	1050-1350	0.30	2.15	130 @ 1200	0.027 @ 1200
" (S.Stl)	" " 1450	1450	1550-1950	0.165	3.00	187 @ 1600	0.075 @ 1800
H.S. Steel	Liquid Heat 1550	1550	1650-2350	0.163	2.88	180 @ 2100	0.070 @ 2100
" "	" " Q-1138	875	920-1450	0.33	1.68	105 @ 1200	0.028 @ 1200
" "	" " 720	875	950-1450	0.28	1.83	114 @ 1200	0.03 @ 1200
Nitrate	Draw Temp 275	275	350-1000	0.36	1.76	110 @ 800	0.016 @ 900 0.052 @ 600
"	" " 430	430	550-1100	0.38	1.84	115 @ 800	0.017 @ 900 0.052 @ 600
"	Mar-Temp Salt	285	350-1000	0.36	1.92	120 @ 400	0.065 @ 400
Neutral	Draw Temp 800	950	1025-1400	0.16	2.19	137 @ 1250	0.06 @ 1100
Brazing	Liquid Heat 110	1450	1550-2100	0.166	3.01	187 @ 1600	0.075 @ 1800
"	Liquid Heat 111	1200	1300-1800	0.172	2.66	165 @ 1550	0.075 @ 1500

Add a dash of HOUGHTON "KNOW-HOW" and get the UNIFORM RESULTS you need!

• A valued ingredient that is not in the formula goes with every Houghton salt you buy—Houghton's wide knowledge of your heat treating problems.

It's the factor which adds extra assurance that your salt bath will be *right* for the job . . . that your heat treated metal will have the precise physical properties you require . . . that you'll be able to maintain the bath so as to get uniform results day after day.

In Houghton's 32-page "Liquid Salt Baths" book, you'll find proof of the benefits you get by using Houghton salts combined with Houghton experience. It shows you how to obtain faster, surer heat treating with salts. Ask the Houghton Man for a copy, or write to E. F. Houghton & Co., Philadelphia 33, Pa.

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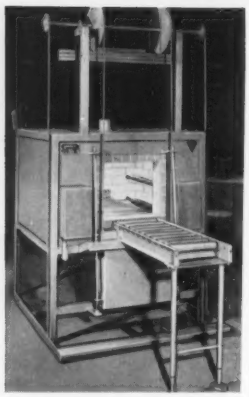
Ready to give you on-the-job service . . .

Electric Roller-Hearth Furnace



Pereny Equipment Company, 893 Chambers Road, Columbus 12, Ohio, has introduced a new electric roller-hearth furnace designated as model RH-68. Chamber size of the new unit is 15" wide, 30" deep and 15" high; maximum operating temperature is 1500°F.

The manufacturers state they are also prepared to build this unit to specialized job requirements using various types of heating elements and automatic temperature controls.

Alloy Casting Institute Undertakes New Research Projects

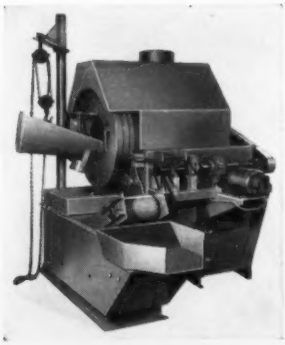
Recent meetings of ACI technical committees have resulted in a schedule of research for the next five years covering a number of projects in the fields of heat and corrosion resistance as well as alloy conservation.

Typical of the projects outlined is one to be conducted at Battelle Memorial Institute on the use of low carbon wrought stainless steels at service temperatures of 1000°F. to 1600°F. Another study authorized at Battelle involves an investigation of the comparative resistance of three heat resisting grades, HH, HK and HT, to carburizing atmospheres at 1700°F. to 1800°F. At present, the HT grade is normally used in carburizing service, but previous research and some field experience indicate that the other two grades may be used as well.

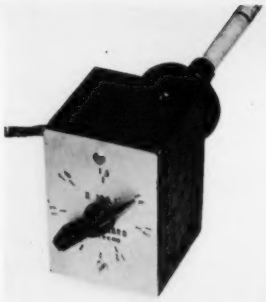
A very considerable amount of corrosion research has also been authorized by ACI at Ohio State University under the direction of Dr. M. G. Fontana.

New Wire Galvanizer

Morrison Industries, Inc., 17100 Miles Avenue, Cleveland 28, Ohio, has developed a medium sized machine for galvanizing and bluing small parts. The machine produces from 600 to 1000 pounds per hour and requires about 10 square feet floor space. The simple operating cycle consists of charging the main cylinder with nails and zinc, in the case of galvanizing, heating the cylinder from brick lined combustion chamber, then discharging the load by reversing the cylinder rotation. A mesh belt carries parts to a drying pan which is heated to speed up drying.



High Temperature Thermostat



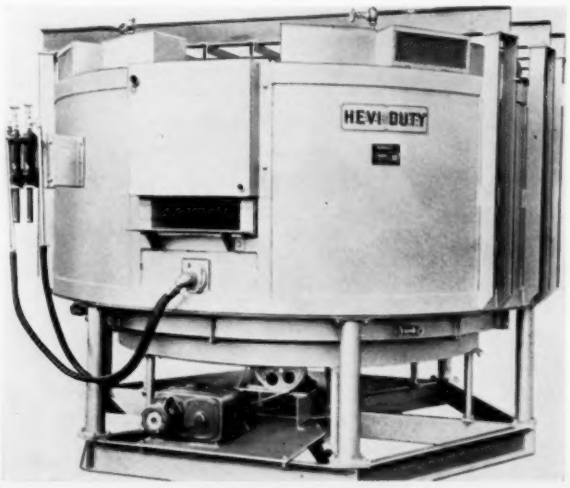
A high temperature thermostat for use between 600°F. and 2000° F. is being manufactured by Kiln-Gard, 38 Normandy Road, White Plains, N. Y. This mechanically operating control is of simple construction and reasonable price. The expansion and contraction of an Inconel rod in relation to a porcelain tube in which it is encased operates the plunger of a microswitch. The control is very valuable as a safety check in conjunction with a thermocouple operated instrument.

The control switch is rated at 15 amperes for 125, 250 or 400 volts A.C. For greater or direct currents, a remote solenoid switch is operated by the control which can be arranged for manual set, optional temperature holding or shut-off. The fluctuation of the holding temperature ranges from 3% to 4% depending upon the setting. The control comes in three dial calibrations, 600-1200°F., 1200-1800°F., and 1400-2000°F.

Rotary Hearth Furnace

An electric rotary hearth furnace has been developed by Hevi Duty Electric Co., Milwaukee 1, Wis., designed to operate continually at temperatures up to 2600°F. with protective atmospheres. The furnace has a rating of 260 KW with a capacity of 1500 pounds per hour. Silicon carbide rod type heating elements are arranged vertically for easy replacement, even while the furnace is hot. The seven foot diameter rotating hearth has a variable speed drive, door opening is 18" wide and adjustable between 6" and 10" in height. For the benefit of the operator, a water cooled face has been installed over the chamber opening.

(Continued on page 14)



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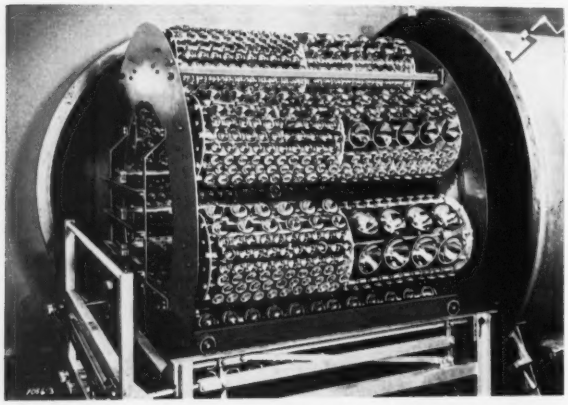
Vacuum Metallizing

Vacuum metallizing is finding greater application in view of low processing costs, brilliant finishes and economical consumption of critical materials. The process consists of placing articles to be coated in a bell jar or steel tank with small amounts of the metal to be coated placed on filaments in the chamber. The chamber is then evacuated and a low voltage current supplied to the filaments which become incandescent and heat the coating metal above its boiling point.



The metal vapor formed condenses on the articles in the chamber, producing a bright coating of microscopic thickness.

The appearance of the coated surface may be varied by either undercoating or overcoating depending upon the effect desired. The photograph shows lamp reflectors being removed from the vacuum chamber of an installation made by the Equipment Division of National Research Corporation, Cambridge, Mass.

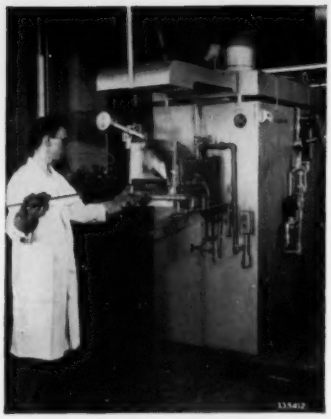
Heat Resistant Goggles

American Optical Company, Safety Products Division, of Southbridge, Mass., has developed several new features for goggles to be worn on jobs where extreme heat is a factor.

A non-toxic, heat resistant and perspiration proof vinyl binding on side shields, eye binders and bridges is more comfortable and lasts longer than leather.

With permanently stitched-on eye binders, bridges and heat-sealed side shields, these vinyl-clad metal goggles can be washed or sterilized as often as is necessary.

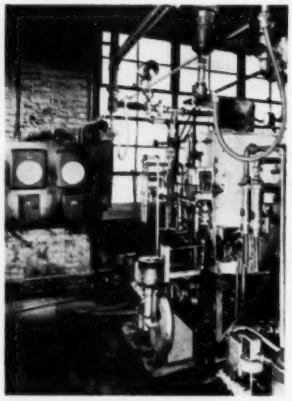
New Westinghouse Furnace



Temperatures up to 3100°F. can be obtained in a new furnace manufactured by Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa. The furnace is designed for hydrogen or dissociated ammonia atmospheres in both heating and cooling. Four manually operated, counterbalanced doors separate charging, heating and cooling chambers. Intended for batch type heating, the work is handled on trays and manipulated by push and pull rods.

The cooling chamber is constructed of welded steel plate, incorporating a water jacketed housing. Heating elements are formed from molybdenum alloy rod and are supported on alundum refractories. The furnace hearth is also made of molybdenum alloy. Protective atmosphere gas consumption is between 150 and 200 cubic feet per hour.

Dew Point Recorder



A guide to proper gas composition in heat treating furnaces is provided by a Foxboro Dew Point Recorder, which measures moisture content of gas atmospheres. Made by the Foxboro Company of Foxboro, Mass., the recorder monitors a continuous sample of gas. The unit consists of a two-pen recorder, a Dewcel power unit and two sensitive elements (dry bulb and Dewcel). A minute gas sample from the furnace is piped to a sampling chamber where dewpoint is measured within ±1°C. A second pen records gas ambient temperatures, which must be in a range related to the dew point measurements. Gas sample temperatures can be brought within this range by lengthening the pipe between the furnace and instrument or installing a small water coil heat exchanger for cooling.

The manufacturer states that the humidity sensitive Dewcel element provides a laboratory standard of measurement even in severe industrial service.

(Continued on page 34)

15 TYPES
INDUSTRIAL POT FURNACES . . .
GAS - OIL - ELECTRIC.
SALT BATH CONVEYORS.

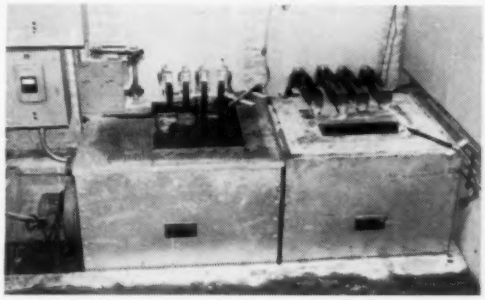
HOLDEN
METALLURGICAL
PRODUCTS
TRADE MARK REGISTERED

50 SALT BATH
COMPOSITIONS FOR ANY
HEAT TREATING APPLICATION.
BLACKING BATH.

TYPICAL INSTALLATION USED FOR AUSTEMPERING STEELS

TYPE 401 FURNACES

1. Pumps hot salt, with one pump, at a minimum rate of 100 gallons per minute.
2. Filters the sludges from the salt below the screened area in a trough approximately 8" deep x 6" wide in which filter screens are utilized.
3. Forced cooling for large production is accomplished by the use of an eight ounce blower which extracts hot air from the surface of the pot, and where necessary, a small jet of water is introduced at the entrance point of the cool air for added cooling speeds on large production applicants.



Type 401-4
Marquenching-Austempering
Unit

Type 701-4
Submerged Electrode Furnace
with removable electrodes

AUSTEMPERING HARDNESS VALUES
VERSUS CHEMISTRY AND SIZE

Type of Steel	C	Mn	CR	Ni	Mo	Rc-max.	Max. dia. round or equiv. sq.-in.
Carbon	0.95-1.05	0.30-0.50	—	—	—	57-60	0.148
Carbon-Mn	0.95-1.05	0.60-0.90	—	—	—	57-60	0.187
Carbon	0.80-0.90	0.30-0.50	—	—	—	55-58	0.156
Carbon-Mn	0.80-0.90	0.60-0.90	—	—	—	55-58	0.218
Carbon	0.60-0.70	0.60-0.90	—	—	—	53-56	0.187
Carbon-Mn	0.60-0.90	0.90-1.20	—	—	—	53-56	0.281
Carbon-Mn	0.60-0.70	1.60-2.00	—	—	—	53-56	0.625
Alloy	0.65-0.75	0.75-0.95	—	—	0.25	53-56	0.625
Alloy	1.00	0.40-0.60	0.40-0.60	—	—	57-60	0.312
Alloy (SAE4150)	0.45-0.55	0.60-0.90	0.80-1.10	—	0.15-0.25	52	0.500
Alloy (SAE4365)	0.60-0.70	0.50-0.80	0.50-0.80	1.50-2.00	0.30-0.40	54	1.0 or lgr.

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Heat Treating Abstracts

Salt Bath Case Hardening

At elevated temperatures, alkali molybdates and tungstates are reduced to metal by hydrogen. The presence of iron confines this reaction to a controlled separation of molybdenum and tungsten at the surface of the iron at lower temperatures. This results in not merely a metallic deposition but an alloying with the iron.

The use of high bath temperatures causes bath decomposition as well as diffusion, therefore, a temperature must be selected to balance both reactions. Figure 1 shows curves giving depth of penetration. To offset bath decomposition, molybdenizing is done below 1830°F, tungstenizing between 1900 and

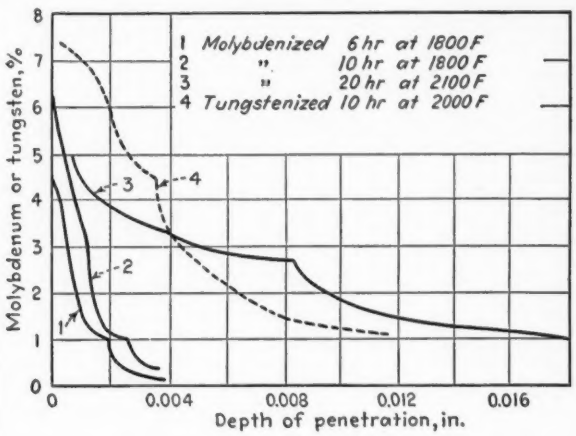

Fig. 1—Molybdenum or tungsten content of the diffusion zone.

2000°F. Cracked ammonia has also been found satisfactory for use in molybdenizing. It is also possible to use a combined molybdate and cyanide and cyanide bath; a bath containing two parts sodium molybdate and one part potassium cyanide will give a case depth of 0.0006 to 0.0008" of high hardness after five hours at 1875°F.

Carbon retards the diffusion of both elements and in general 0.5% is the limiting factor above which little or no diffusion occurs. Indications are that only low carbon steels and carbon free irons will find commercial applications with, perhaps, subsequent carburization of the diffusion layer.

A 0.03% carbon iron was molybdenized and tungstenized, then carburized in 92% hydrogen, 8% propane. The results of this work point to a workable process when carburizing and heat treating conditions are balanced. One test gave a Vickers 3kg load hardness of 1200 when carburized at 1760°F. for ten hours and water quenched, after molybdenizing. The case developed by carburizing is quite stable during tempering and has minimum brittleness.

Figure 2 shows the effects of nitriding on molybdenized irons and steels. Maximum hardness is confined to a rather shallow depth. The use of a nitriding temperature above 950°F. leads to the formation of a brittle nitrided zone.

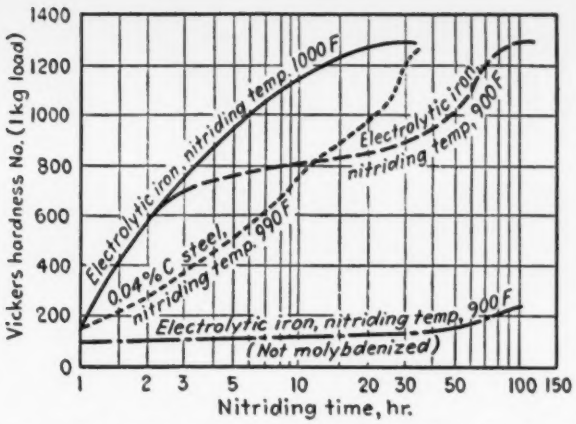

Fig. 2—Hardness of molybdenized iron compared with nitriding time.

It has been found that siliconizing a molybdenized iron results in an acid resistant case equal to that found in 15% silicon, 3% molybdenum irons.

(Abstracted from "Salt Bath Case Hardening With Molybdenum and Tungsten," E. Fitzer, Materials and Methods, March 1953).

Explosion-Proof Atmosphere Control Devices

Among the new devices for heat treating of metals described before a recent meeting of the Metal Treating Institute, one of the most interesting was one which is designed to remove much of the hazard from the operation of controlled atmosphere furnaces. The review of advances in the field was given by Mr. V. H. Ferguson, President of Ferguson Equipment Corp., Pittsburgh, Penna.

The most common atmospheres used in metal treating are of the endothermic type which are both toxic and explosive. Thus there is a need to protect the furnaces against malfunctioning.

Explosions occur 1) when gas gets into a chamber where only air should be present, or 2) when air gets into a chamber where only gas should be. In the first instance, the explosion would be caused when the furnace is filled with air and then fuel gas or the protective atmosphere is introduced into the chamber when its temperature is below the ignition point. Gas plus air mixes into an explosive combination which is likely to explode when the furnace temperature is raised or the burners are lighted in an open-fired furnace.

The second type of explosion hazard exists with furnace chambers or vestibules which normally operate entirely filled with protective atmosphere. The hazard is created when air leaks into these areas.

The protective device consists of an electrically heated tube which is maintained at a temperature above the ignition point of the gases. A schematic diagram is shown (page 28).

In open-fired furnaces the unit would be located in the top of the furnace and would tend to burn the fuel gas in small quantities as it is collected in the top of the chamber. The gases collect in the top

(Continued on page 28)

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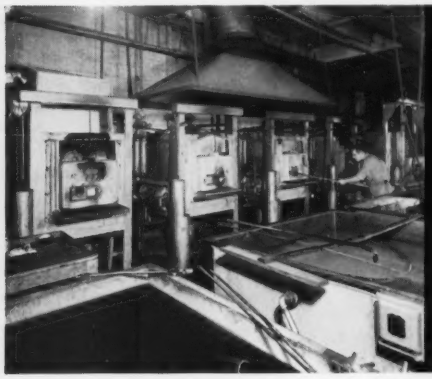

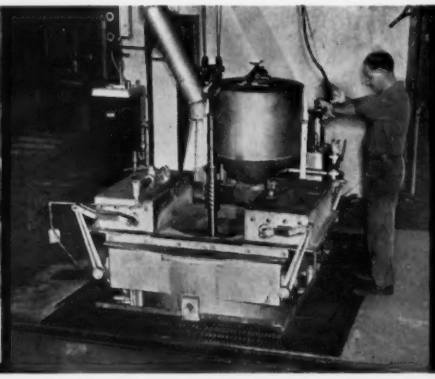

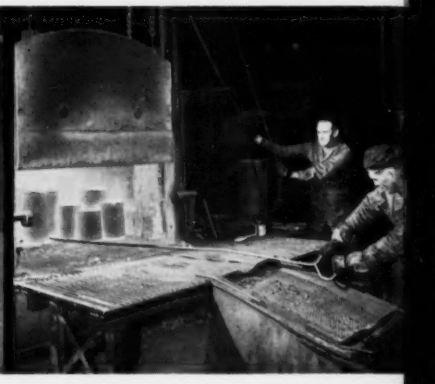

THE REASONS for the growth and national acceptance of the commercial heat treating industry are numerous, but fundamentally are based upon one important factor namely "Completeness Of Service" from A to Z—all under one roof.

Of equal importance is the fact that this very versatility automatically with time creates an equally wide variety of skills — skills in handling and processing all types of heat treating from simple stress relief to delicate controlled atmosphere hardening, cyaniding, etc.

In the true sense of the word your commercial heat treater is a "Specialist" with his entire organization established and built around "*Service*."

The members of The Metal Treating Institute are the recognized leaders of the field and comply with the high quality standards established by such a group.

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Industrial Steel Treating Co.
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or consult the MTI members listed above

Institute News . . .

ANNUAL SPRING MEETING

Representatives of the Commercial Heat Treating Industry from all parts of the United States met at the Hotel Shamrock, Houston, Texas, for the Annual Spring Meeting of the Metal Treating Institute, May 18-20, 1953. Full details will appear in the next issue.

The latest affairs of the Institute were discussed at Business Sessions and the members present also heard the following interesting technical discussions:

"New Heat Treating Methods for Alloyed Materials"—Mr. Howard Scott, Westinghouse Electric and Manufacturing Co.

"Quality Control in the Commercial Heat Treating Plant"—Mr. Charles F. Lewis, Cook Heat Treating Co. of Texas.

PAST PRESIDENT RECOGNIZED

In accordance with the resolution unanimously passed by the members at the last Annual Meeting, a certificate of appreciation was prepared and presented to J. Walter Rex for the interest and time devoted during two terms as President (1951-1952). The scroll reads as follows:

Presented to J. WALTER REX In Recognition
1951-1952
of his two years loyal and unselfish service as President of the Metal Treating Institute as an expression of gratitude and appreciation of the members.
January 1953—MTI

MEMBER APPOINTS NEW MANAGER

Carl C. Brereton, President of Supreme Metal Treating Company, 4440 West Mitchell St., Milwaukee, has announced the appointment of Arnold E. Jakel as General Manager. Mr. Jakel was formerly Assistant Chief Inspector of the Heil Company. A Naval Academy graduate of 1938, Mr. Jakel received his masters degree in 1944 from the Massachusetts Institute of Technology. Mr. Jakel left the Navy in 1949 and held the rank of Commander when he resigned.

COMMITTEE APPOINTMENTS

The following committees have been appointed by President A. M. Cox:

Publication Committee—Horace C. Knerr, Chairman, Metlab Co., Philadelphia. Charles Heilman, Commonwealth Industries, Inc., Detroit. Elmer Cox, Pittsburgh Commercial Heat Treating Co., Pittsburgh. Fred Heinzelman, Jr., Fred Heinzelman & Sons, New York.

History Committee—C. U. Scott, Chairman, C. U. Scott & Son, Rockford, Ill. Fred Heinzelman, Sr., Fred Heinzelman & Sons, New York. Charles Heilman, Commonwealth Industries, Inc., Detroit. C. Graham, Metal Treating, Inc., Milwaukee.

Cost Accounting Committee — Purdy Benedict, Chairman, B-M Heat Treating Co., Lyndhurst. Charles H. Hewitt, The Dayton Forging & Heat Treating Co., Dayton. Conrad Knerr, Metlab Co., Philadelphia. A. D. Bach, New England Metallurgical Corp., South Boston. Kenneth Jenks, Lindberg Steel Treating Co., Chicago. Henry Cooke, Jr., American Steel Treating Co., Crystal Lake, Ill. L. S. Miel, Commercial Steel Treating Corp., Detroit.

Heat Treating Hints Committee — Fred Heinzelman, Jr., Chairman, Fred Heinzelman & Sons, New York. Frank Rizzo, L-R Heat Treating Co., Newark. Robert Cox, Pittsburgh Commercial Heat Treating Co., Pittsburgh. Earl P. Brane, Nerl Heat Treating Corp., South Bend. Arlo E. Leidig, Hollywood Heat Treating Co., Los Angeles. Ben Berlien, Industrial Steel Treating Co., Oakland. J. W. Rex, J. W. Rex Co., Lansdale, Pa. L. J. Haga, State Heat Treating, Inc., Grand Rapids. Don Campbell, Senecca Heat Treating Co., Batavia.

Fall Meeting Committee — C. W. Derhammer, Chairman, The Lakeside Steel Improvement Co., Cleveland. John R. Gier, Jr., Ferrotherm Co., Cleveland. G. H. Griffiths, Reliable Metallurgical Svc., Inc., Cleveland. George Porter III, The Geo. H. Porter Steel Treating Co., Cleveland. Alexander Winton, Jr., The Winton Heat Treating Co., Cleveland.

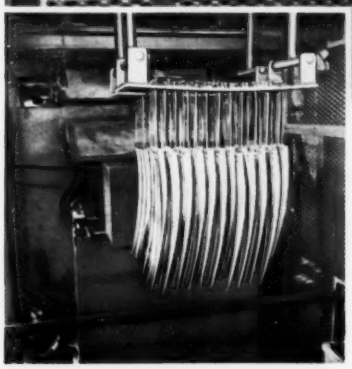
Nominating Committee—Roy Lindberg, Chairman, Lindberg Steel Treating Co., Chicago. Ben Berlien, Industrial Steel Treating Company, Oakland. Ray Sault, Porter Forge & Furnace, Inc., Somerville, Mass. George Porter III, The Geo. H. Porter Steel Treating Co., Cleveland. Clarence Graham, Metal Treating, Inc., Milwaukee.

Safety Committee—Si. Edwards, Chairman, Industrial Steel Treating Co., Oakland. A. T. Ridinger, Metallurgical Control Labs., Minneapolis. Lloyd G. Field, Greenman Steel Treating Co., Worcester, Mass. A. D. Bach, New England Metallurgical Corp., South Boston. B. F. Rassieur, Paulo Products Co., St. Louis.

It is hoped that each committee will have a complete report prepared for presentation at the Annual Meeting of the Institute in October. A special committee luncheon held at the recent Spring Meeting brought forth a number of suggestions for the working procedures of the various committees and it is felt that they are all well under way.

The Yard-Man Story:

How Park Salt Baths harden 4500 lawnmower blades a day!



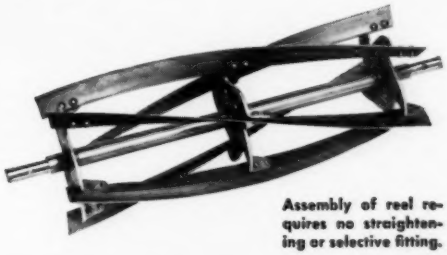
Electrically heated furnace, operated by one man, both hardens and quenches.

Process treats 55 blades every five minutes. No special quenching fixtures are needed.

There's a lifetime of rough treatment and rugged wear in store for most lawnmowers. That's why at Yard-Man lawnmower blades are precision heat treated in production quantities by austempering in Park salt baths. Park Nu-Sal and Park Thermo-Quench are used at Yard-Man to insure their blades the critical combination of hardness and toughness required. SAE 1065 blades, 55 per rack, enter and leave the furnace at 5 minute pushes. Park Nu-Sal neutral salt is the high heat at 1550°F. Quench is in Park's Thermo-Quench salt at 590°F.

Salt austempering eliminates scale, decarb and quenching cracks. Modern salt heat treating gives more and better production with less labor and floor space. One man handles the entire process, including loading and unloading. After salt bath treatment, reels are assembled *without the need of straightening or selective fitting.*

At Yard-Man, they've had over 2½ years now of trouble-free austempering with the Park salt baths . . . while maintaining their average production of 4500 lawnmower blades a day!



Assembly of reel requires no straightening or selective fitting.

MODERN SALT BATH HEAT TREATING CAN BENEFIT YOU!

Nu-Sal Neutral Salt	Thermo-Quench Salt
M.P. 1230°F. W.R. 1300-1650°F.	M.P. 290°F. W.R. 325-1100°F.

Salt baths, the near perfect heating medium, offer tremendous advantages over conventional heat treating methods. As much as 80% of all heat treating *can be done better in salt!* Tools and dies, gears, bearing races, springs, cylinder sleeves, blades, automotive parts, agricultural implements, machine parts, ammunition and gun parts, just to name a few. Benefit your own product! You'll lower costs, increase quality by eliminating quench cracks, prevent scaling and decarb, increase toughness and ductility, and speed handling. You'll find, too, that Park austempering cuts labor costs while conserving valuable floor space!

• Liquid and Solid Carburizers • Cyanide, Neutral, and High Speed Steel Salts • Coke • Lead Pot Carbon • Charcoal • No Carb • Carbon Preventer • Quenching and Tempering Oils • Drawing Salts • Metal Cleaners • Kold-Grip Polishing Wheel Cement

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Tool Steel Topics

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INTRODUCING BEARCAT TOOL STEEL

Super Shock-Resisting ...Versatile, Too!

Here's a brand-new tool steel that we've been developing over the past several years. Proven in a wide variety of production tools and dies, Bearcat is a general-purpose steel especially suited for uses where shock-resistance, hot-work properties and easy machining are important.

Some of Bearcat's big features:

- Super shock-resistance
- Deep-hardening . . . in air
- Easy to machine (Brinell 197 max)
- Low distortion in heat-treatment
- Good hot-work properties
- Easily carburized for long wear

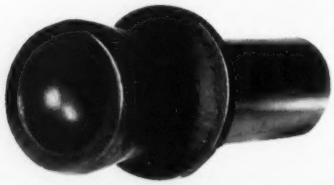
These are not just claims made for a new, untried steel! Bearcat has been thoroughly tested in applications such as rivet sets, hot gripper dies, punches, chisels, moil points, forming dies. All of the possible uses for Bearcat have not yet been explored, but we expect it to be ideal for hot headers, blanking dies, master hobs, machined-cavity molds, and many general-purpose tools and dies.

Bearcat is stocked in our mill depot and it's also available through your local Bethlehem tool steel distributor.

Typical analysis:

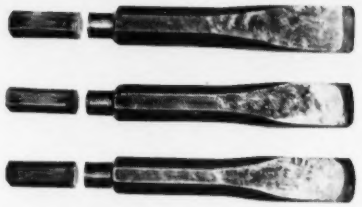
C	Mn	Si	Cr	Mo
.50	.70	.27	3.25	1.40

Complete data may be had by writing us for Booklet 341. Address your request to Room 1037, Publications Dept., Bethlehem Steel Co., Bethlehem, Pa.



BEARCAT DRIVES 27 TIMES MORE HOT RIVETS

Here's one example of what Bearcat can do on a job that calls for both shock-resistance and good hot-work properties. This typical rivet set, made from Bearcat, drove 43,094 rivets and was still in good condition. Rivet sets made from carbon tool steel, and used under similar conditions, drove an average of only 1566 rivets before recupping was required.



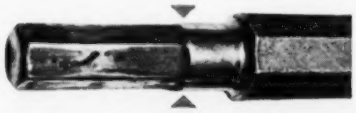
All of the chisels broke in service at the sharp change of section. While this is classed as a mechanical error, it does show how improper design can cause failure no matter how carefully a tool may be heat-treated.

Chisel Breakage Cured by Undercutting Shanks

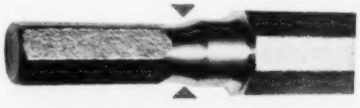
A large user of chisels—made from a top-grade shock-resisting steel, Bethlehem Omega—reported excessive breakage. One of our metallurgical sleuths soon put his finger on the trouble.

When the hexagon shanks were milled by the customer, a milling cutter was used which did not have an adequate radius. As a result, stresses were concentrated at the sharp change of section in the shank. Subjected to heavy impacts in air hammers, the chisels broke prematurely—and always at this portion of the shank.

The solution for the breakage was one that really surprised the customer. See photographs below.



This shank shows the "stress raiser," caused by the lack of sufficient radius, where the milled hexagon section meets the round section.



All of the unused chisels were salvaged by having an undercut ground on the shanks so that a ½-in. radius was provided at the source of the trouble. Despite the smaller section, these chisels gave good service. The sharp change in section was eliminated, stresses were better distributed.

THE BETHLEHEM TOOL STEEL ENGINEER SAYS:

High-Carbon Tool Steels Can Be Carburized

Many people don't realize that carburizing can be accomplished with the high-carbon, high-chromium steels—such as our Lehigh H, which contains 1.55 pct carbon and 11.50 pct chromium. The carburizing of tools made from such steels can be either helpful or harmful, depending upon whether the carburized case is produced intentionally or accidentally.

Tools intended for light loads and long service, such as lamination dies, are often intentionally carburized before quenching. Such dies have greatly improved resistance to wear because of the carbon added to the wearing surfaces. The usual procedure is to use carburizing compound as a packing medium and heat for the normal length of time at the quenching temperature.

Sometimes an accidental carburized case results when "spent" carburizer is used as a protective packing medium when heating for hardening. Spent carburizer is often almost as active as new carburizer. An accidentally produced carburized case is not always harmful. It may even be helpful. But there are many heavy-duty tools and dies that will develop chipped or spalled edges if they become carburized. When treating tools of this type, use cast-iron chips as a packing medium during hardening.

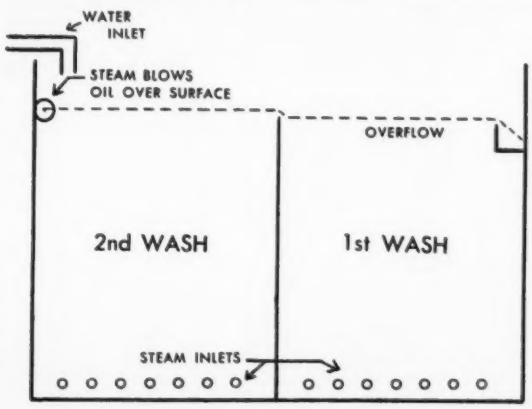
HEAT TREATING HINTS

Cleaning Parts After Heat Treatment

The problem of cleaning heat treated parts, seldom pleasant or totally effective, has been successfully overcome and we are now enjoying excellent results and savings. A combination of E. F. Houghton and Company's "Houghto-Clean #245" and "Cerfak Liquid" is doing a variety of work in our New York plant.

Cyanided work, after oil quenching, formerly required considerable time to thoroughly remove the salt from blind holes. Furthermore, unless tumbled in saw dust, light parts failed to dry and rusting would occur. Now thorough cleaning is possible in 5 to 15 minutes and no rusting occurs.

One tank used in this operation is shown below. It holds 140 gallons and is divided by a partition



over which the final section spills into the first wash. A drain gutter in the first wash section is lower than the top of the partition. A raw steam line facing the partition drives oil flotation across the second wash, over the partition and into the gutter in the first wash. Raw steam outlets in both sections of the tank heat the solution.

Due to the constant fresh water addition to the solution and the resultant spillover and drainage, a charging of the tank for the week would be wasteful. Consequently, after starting each Monday with a tank of fresh water containing 4 pounds of #245 and 1 quart of Cerfak Liquid, we make a daily addition of 2 pounds #245 and 1 pint of Cerfak Liquid to each section of the tank.

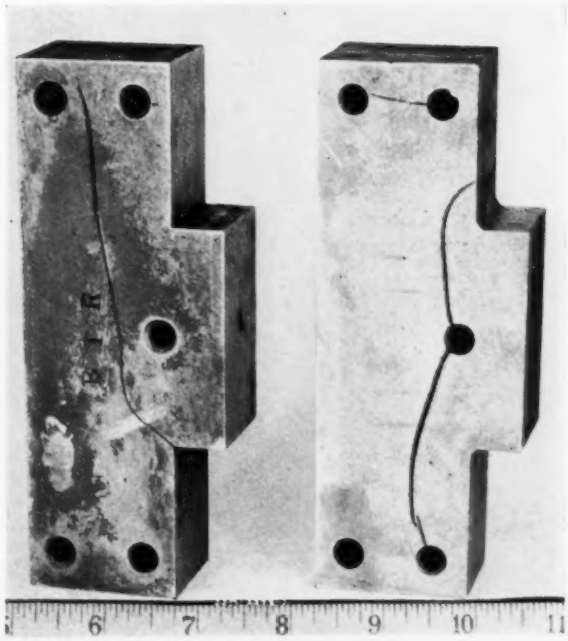
"Baskets" made from five gallon drums with screen bottoms holding 30 to 50 pounds of thin section work are used in the tank. Such a basket will clean in 5 to 8 minutes and will be dry within 5 to 10 minutes. Blind holes in oil quenched cyanided work will clean in 10 to 15 minutes.

Another application of this combination is the cleaning of work from a shaker hearth furnace dropped into an oil quench. A conveyor carries the work out of the quench and into a 225 gallon cleaning tank heated by raw steam. An automatic conveyor carries parts through the length of this tank and a one pipe double spray of the cleaning solution located above the solution level. The parts then drop onto another conveyor which carries them through a gas heated drying section six feet long and finally into a container scheduled for tempering.

This last operation removes a total of 15 gallons of quenching oil per week. Because of the great volume of oil going into the bath, due to the shape of some of the parts treated, it is necessary to dump the bath twice a week. An addition of 4 pounds of #245 and 1 quart of Cerfak Liquid is sufficient to clean all work during an eight hour shift.

FRED HEINZELMAN, JR.
Fred Heinzelman & Sons
New York, N. Y.

Preventing Cracks Through Proper Design and Tempering



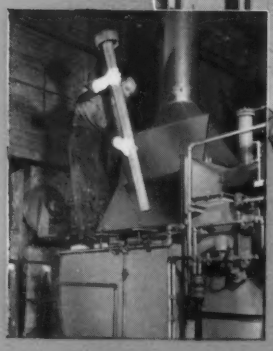
The two dies shown above illustrate some types of difficulties which can be encountered in a relatively simple tool. The dies cracked primarily because they were not tempered after the quench. The die at the left cracked through a sharp corner which was not essential in the design. The crack relieved the quenching stresses sufficiently so that a similar corner did not crack, nor did any cracking occur near the holes.

(Continued on page 33)

Here's the new..

LINDBERG CARBONITRIDING FURNACE

It's many-furnaces-in-one! • It's designed not only for carbonitriding .. but also for hardening, carburizing, annealing and carbon restoration! • It's a self-contained unit! • It's easy to maintain!



Change tubes like the blades in your razor! It's easy to change the new thin-wall tubes—just lift 'em out and hang new ones in place . . . all in a matter of minutes.

The greatest advance in industrial furnace design and construction since Lindberg introduced the Cyclone forced convection tempering furnace back in 1935!

A 320 lb. load of CRS sleeves. Carbonitrided .010 to .015". 90 minutes in heating chamber. Temperature, 1600° F.

A 400 lb. load of CRS hex nuts. Carbonitrided .001 to .005". 60 minutes in heating chamber. Temperature, 1600° F.

Yes, you must see the new Lindberg Carbonitriding Furnace. It's many furnaces in one . . . it's easy to maintain . . . it's a self-contained unit.

Check these important construction features . . . features that will improve production quality and volume, and reduce production costs.

Many furnaces in one . . . Furnace atmosphere is provided by the Lindberg "Hyen" endothermic atmosphere generator that is easily adjustable to supply different atmospheres not only for carbonitriding, but also for carburizing, carbon restoration, bright hardening or annealing and normalizing. For annealing and normalizing the heated charge cools in the same chamber used for purging.

Easy to maintain . . . Instead of old style, heavy, unwieldly, horizontal radiant tubes . . . new gas-fired, lightweight tubes (only 29 pounds) are used. They're simple to change . . . turn off the gas . . . get on top the furnace . . . lift out the old tube . . . hang a new one in its place . . . and the thin, rolled metal tubes actually last longer!

Quench tank pit unnecessary . . . Your Lindberg Carbonitriding Furnace is self-contained, including a built-in pitless quench tank . . . thus you avoid costly excavation and piping. But more important, this built-in quench tank minimizes distortion . . . quenching takes place within the furnace structure, by means of a vertically operated elevator. Heated charges are never exposed to the air . . . as is the case when work is transferred from the heating chamber to a separate quench tank. Uniform case depth is assured because each charge automatically remains at heat the same length of time.

Purge chamber . . . A specially designed chamber, built immediately above the quench tank and in front of the heating chamber, receives work load for purging prior to heating.

A 120 lb. load of CRS screws. Carbonitrided .005 to .008". 45 minutes total time...temperature, 1580° F.

For full details ask for Bulletin 241

Lindberg Engineering Company — 2466 W. Hubbard Street, Chicago, Illinois

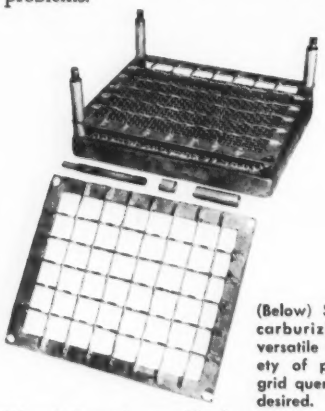
LINDBERG FURNACES

ROLOCK
FABRICATED ALLOYS
HEAT AND CORROSION RESISTANT

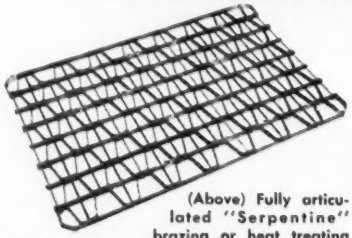
WHY FABRICATED?

All Rolock heat treating equipment is fabricated... not cast. Every carrier is job-engineered for the specific use and made from the correct metals and alloys for maximum resistance to all conditions of exposure, shock and abrasion. Especially successful are Rolock applications of nickel alloys . . . replacing heavy castings with durable, lighter weight fabrications. The examples shown below, while custom-built, can be adapted to your needs. We welcome your requests to solve your heat treating equipment problems.

(Above) Stainless drop-bottom pit furnace basket for quality, uniform heat treat. Saves seconds between heat and quench.

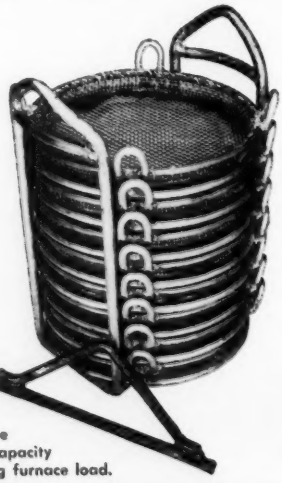


(Above) Rugged assembly for carburizing shafts in pusher furnace. Adjustable posts position fabricated alloy screens; mesh to suit work. Light weight, high pay load, long life.

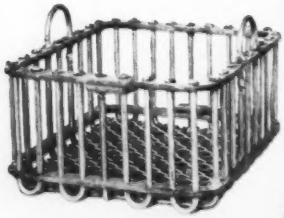


(Above) Fully articulated "Serpentine" brazing or heat treating tray, retains shape. Heavy or light, any width, length, depth. Many uses at lowest hourly cost.

(Below) Sectional lift post carburizing fixture. Most versatile for handling variety of parts. Each loaded grid quenched separately, if desired.



(Right) Inconel basket assembly for nitriding. Only required baskets need be used for less than capacity operation . . . reducing furnace load.



(Above) Alloy carburizing basket. Loose joints expand under heat. Rugged, flexible construction resists abuse.

Offices in: PHILADELPHIA • CLEVELAND • DETROIT • HOUSTON • CHICAGO • ST. LOUIS • LOS ANGELES • MINNEAPOLIS • PITTSBURGH

ROLOCK INC. • 1232 KINGS HIGHWAY, FAIRFIELD, CONN.

JOB-ENGINEERED for better work
Easier Operation, Lower Cost

3RL838

WHAT'S YOUR PROBLEM?

ED. NOTE: Frequently "*Metal Treating*" is asked for answers to heat treating problems of various types. These are referred to technicians, metallurgists, etc. The correspondence below is typical.

Send *us your problem*—we'll try to get the answer and publish it for your benefit and others.

Dear Mr. Herington:

I would like to know what material can be used for pack annealing which is neutral to a steel like 4130. Sometimes we want to pack anneal parts machined from this steel and we do not want to carburize them nor decarburize them. We would like to use something that is not too dense so as to not impede the heat from transferring throughout the load.

Any information that you can give us on this subject will be appreciated.

Sincerely yours,

B. F. RASSIEUR
President

Paulo Products Co.
St. Louis, Mo.

Dear Mr. Rassieur:

In answer to your letter of May 5th on a neutral pack for annealing steel, there are two materials which can be used. Cast iron chips work out quite well as far as preventing carburization or decarburization is concerned but they are quite dense and slow down the rate of heat transfer throughout the load.

The other material which we have found to be successful is spent pitch coke. This material is comparatively light and will not interfere with heat transfer to any great degree. However, the coke usually supplied will tend to carburize. This can be overcome to a large extent by first burning the coke at approximately 1900°F. for several hours.

Sincerely yours,

FRED HEINZELMAN, JR.

Fred Heinzelman & Sons
New York, N. Y.

LETTERS TO THE EDITOR

Dear Editor:

We are very interested in the periodical METAL TREATING, published by your Institute, which we receive regularly.

Therefore we would appreciate it very much to receive the issues of METAL TREATING which will appear in the future.

Thanking you in advance, I remain,

DR. E. M. H. LIPS
N.V. Philips' Gloeilampenfabrieken
Eindhoven, Nederland

Dear Editor:

Read your interesting Editorial in the January-February issue of METAL TREATING, covering the Classification of Tool Steels. The Society of Automotive Engineers apparently has finished its work on standardization of Tool Steels. Can you tell me where a copy of this may be obtained?

Also noted that the Joint Industry Conferences are standardizing Tool Steels. Have they completed their work? If so, are copies of their data available?

Enjoy your excellent magazine very much. Thank you for any information you can give me on the above.

L. G. MILLER
Chief Metallurgist
Greenlee Bros. & Co.
Rockford, Illinois

Dear Editor:

Your publication is both informative, interesting, and upholds the technical standards of our leading technical journals.

Mr. J. Walter Rex, in whose shop I first encountered your magazine, assured me that you would be happy to place my name on your mailing list. I will greatly appreciate this favor.

L. E. GATZEK
Production Metallurgist
Affiliated Gas Equipment, Inc.
Cleveland, Ohio

(Continued on page 31)

RETORTS
FOR
PIT TYPE
FURNACES

from Stock!

Hundreds of our retorts have been purchased on the basis of low cost service life. Now the same well-known quality retorts are available for immediate delivery "off the shelf."

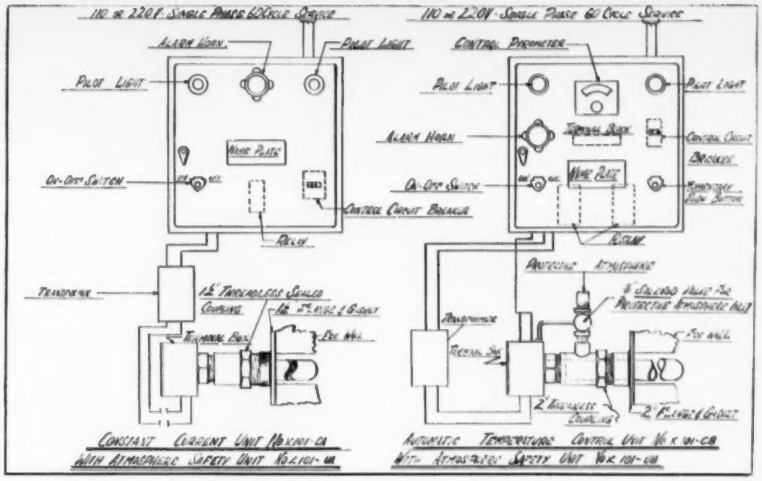
ALLOY ENGINEERED FABRICATION

MISCO FABRICATORS, INC.
Designers, Builders, Fabricators of Heat Resisting Alloys and Stainless Steel Equipment
1999 GUOIN STREET • DETROIT 7, MICHIGAN
TELEPHONE LORAIN 7-1545

of the chamber because their densities are lighter than that of air.

Atmosphere furnaces have the control device in the furnace bottoms and there will tend to burn small quantities of air which might infiltrate into the equipment before the air can mix with the gases and become explosive. The device has automatic controls which cause an alarm to sound and shut down the furnace when the heating unit permits the temperature to fall below the explosion point of the gases.

Among other new developments described were these:



1. A simple internal atmosphere generator for small box type furnaces. The furnace heating elements are used to produce the atmosphere by a special construction. Atmospheres so produced are satisfactory for most types of steels with the exception of those having an extremely high tungsten content.

2. An inexpensive CO_2 removal unit which can be added to a simple exothermic atmosphere generator. The unit will permit the wider use of that nonexplosive atmosphere, since the resulting atmosphere is neutral to steel. The resulting atmosphere could also be used as a purging medium for the vestibules of atmosphere furnaces and could be used in box-type tempering furnaces without hazard.

3. Batch-type carbonitriding furnaces, including a new one which provides for completely mechanized loading, quenching and unloading of the work. The furnace can also be used for stainless hardening, copper brazing and other operations requiring temperatures up to 2100°F.

The speaker suggested that heat treaters might investigate the installation of aluminum melting furnaces in keeping with the trend of small fabricators who are now melting and salvaging their own aluminum scrap. Few plants have sufficient scrap to keep a furnace operating full time; thus a heat treater who could service several plants could justify the investment.

Tempilstiks°

quick, simple, accurate way to tell temperatures

It's this simple: mark the workpiece with the proper Tempilstik°. When the mark melts, the specified temperature has been reached.

use like a crayon

to control working temperatures in:

- welding
- flame-cutting
- tempering
- forging
- casting
- molding
- drawing
- straightening
- heat-treating in general

$2 each gives up to 2000 readings

Available in these temperatures (°F)				
113	263	400	950	1500
125	275	450	1000	1550
138	288	500	1050	1600
150	300	550	1100	1650
163	313	600	1150	1700
175	325	650	1200	1750
188	338	700	1250	1800
200	350	750	1300	1850
213	363	800	1350	1900
225	375	850	1400	1950
238	388	900	1450	2000
250				

Also available in pellet or liquid form.

FREE —Tempil° "Basic Guide to Ferrous Metallurgy" — 16¼" by 21" plastic-laminated wall chart in color. Send for sample pellets, stating temperature of interest to you.

Metal & Thermit Corp. 100 E. 42nd Street, New York 17, N. Y.

FOR SALE

One Surface Combustion Gas Fired 54" x 120" Hearth Furnace with the following approximate specifications:

Outside dimensions 96" wide, 180" long, excluding the loading and unloading tables and pusher mechanism.

Overall Height 9'

Door opening approximately 24" high

Hearth 54" x 120"

Maximum temperature 1800°

Controls and quenching equipment included

Condition good.

Contact T. Cook, Purchasing Department, CATERPILLAR TRACTOR CO. Peoria, Illinois

56-Hour Work Week a Year

... Incoloy retort still going strong at temperatures up to 2050°

Here you see a long life Incoloy hydrogen annealing retort going into the furnace at L. & R.'s shop where it will soak at 2050° F. for 4 hours, then be gradually cooled to room temperature. It was fabricated by the NEWARK METAL PRODUCTS CO., Kenilworth, N. J., from 1100 pounds of Incoloy.

Latest reports on Incoloy®, new companion alloy to Inconel®, include some remarkable service records.

As a hydrogen annealing retort, for instance.

Here—where other metals failed quickly, some in as little as 42 hours — Incoloy has already given over 3,000 hours of service. And it's still going strong.

This Incoloy annealing retort is being used by L. & R. HEAT TREATING COMPANY in Newark, N. J., for heat treating T.V. shields, hearing aid components, and laminators for servo-motors.

What an ordeal this retort goes through!

First, after being loaded, the retort is soaked at 2050° F. for 4 hours. Then the temperature is reduced 100° F. hourly until the retort reaches 1200°F. It is held there an hour and then allowed to cool to room temperature. *A total heat of 14 hours.* And it has to go through this grind four times a week!

L. & R.'s Incoloy retort has been in service a year now and it's still in shape for more of the same.

L. & R., incidentally, was voted a "best shop" commendation by members of the Metal Treating Institute. Their engineers, still watching Incoloy's record, already say service has been "very satisfactory."

The fabricators of the Incoloy retort, NEWARK METAL PRODUCTS CO., Kenilworth, N. J., found that this new member of the Inco family was readily fabricated into heat treating equipment of all types. It is both workable and weldable for maximum flexibility in efficient design.

If you would like to learn more about Incoloy, write for your copy of "Preliminary Report on Incoloy."

It is advisable to place equipment orders with your supplier well in advance of scheduled use. Distributors of Inco Nickel Alloys can supply the latest information on availability from warehouse and mill. The International Nickel Company, Inc., 67 Wall Street, New York 5, New York.

Inco Nickel Alloys

Incoloy... *for Heat-Resisting Applications*

Thermalloy retorts with bayonet-type plug end on the left. Firebricked ends of carbon steel retorts on the right were sealed over with clay paste before use.

THERMALLOY*

outlasts carbon steel retorts . . . 28 to 1

In a plant of a large eastern tool and specialty steel manufacturer, long, pipe-like retorts are used to anneal and heat-treat high-speed carbon and alloy steel bar stock in hood-type furnace equipment. Temperatures range up to 1650°F. during the annealing or heat-treating cycle that may last 30 hours.

Under these conditions, this manufacturer found that wrought carbon steel retorts scaled excessively and also distorted and flattened during operation . . . limiting service life to about 500 cycle hours. For the same operation, centrifugally cast Thermalloy retorts showed no measurable scale loss and maintained uniform wall thickness and shape. When last reported, Thermalloy retorts had been operating over 14,000 cycle hours and were still in perfect condition.

As the wrought carbon steel retorts became distorted, the plugs necessary to seal the open ends would not fit. Firebrick and a clay paste were used to seal the ends against infiltration of furnace gases. This made uniform annealing or heat-treating practically impossible. However, Thermalloy retorts, with plug ends designed by Electro-Alloys, afforded practically gas-tight seals and much greater ease of handling.

Today, this manufacturer is replacing all of the wrought carbon steel retorts with high heat-resistant Thermalloy retorts. Perhaps the same operating economy may interest you in Thermalloy retorts, furnace parts, trays, racks, pots or muffles. For full information, call in an Electro-Alloys engineer or write Electro-Alloys Division, 4003 Taylor Street, Elyria, Ohio.

*Reg. U. S. Pat. Off.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION
ELYRIA, OHIO

Letters to the Editor (cont.)

Dear Editor:

Dick Korff of our heat treating department has seen the January-February issue of your publication METAL TREATING and finds it most helpful. He would appreciate having his name put on your mailing list for future issues. You may address him in care of this company.

Yours very truly,

TOM LARSEN
Purchasing Agent
Woodward Governor Company
Rockford, Illinois

Dear Editor:

The January-February issue of METAL TREATING was recently given me. My survey of the entire magazine convinced me that the information should be available to our departmental personnel. I would like to receive your publication regularly and therefore, ask to be placed on your mailing list. Please advise attendant cost. Thank you.

Yours very truly,

W. H. CHARLESWORTH
Supervisor of Metallurgical Testing
Perfect Circle Corporation
Hagerstown, Indiana

Dear Editor:

We enjoy your magazine very much, and would appreciate it if you could find room for us on your mailing list. Please send us information concerning subscription price, etc. Thank you.

J. E. HAFLINGER
Assistant Metallurgist
The Ohio Crankshaft Company
Cleveland, Ohio

Dear Editor:

Thank you for your letter of the 23rd inst. and for your prompt attention given our inquiry on thermal quenching oils.

We appreciate very much receiving the copy of the METAL TREATING journal and herewith please find your card properly filled out to include our name on your circulation list of the magazine.

ROBERTO M. GIANNATTASIO
Argentine Government Oil Fields
New York, N. Y.

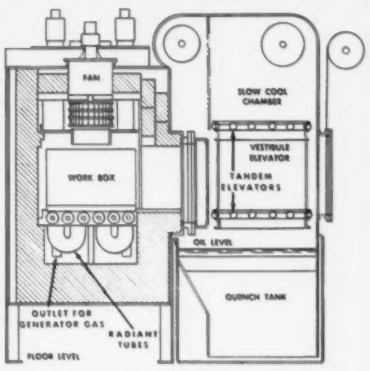
(Continued on page 33)

DOW

FIRST with

MECHANIZED BATCH — TYPE CONTROLLED ATMOSPHERE

FURNACES



MODEL "J"

The Dow Model "J" is a small mechanized furnace for production carbonitriding, gas carburizing, clean hardening, carbon restoration and bright annealing. It is the ideal furnace for small heat treaters and manufacturers where flexibility is required. Size: 7'10" wide, 14'4" long—head room 15'. Production capacity: 250-350 lbs. per hour on light case work.

NOW GIVES YOU A SMALL FURNACE WITH THESE OUTSTANDING FEATURES—

1. Tandem Elevator construction permits reloading furnace while load is in oil quench or slow cool chamber.
2. Fan (5000 cfm) removable from outside and heat capacitors provide positive directional flow of atmosphere.
3. 4 Vertically mounted Radiant tubes with 600,000 BTU per hour input with built-in generator.

DOW FURNACE COMPANY

OPTIONAL FEATURES

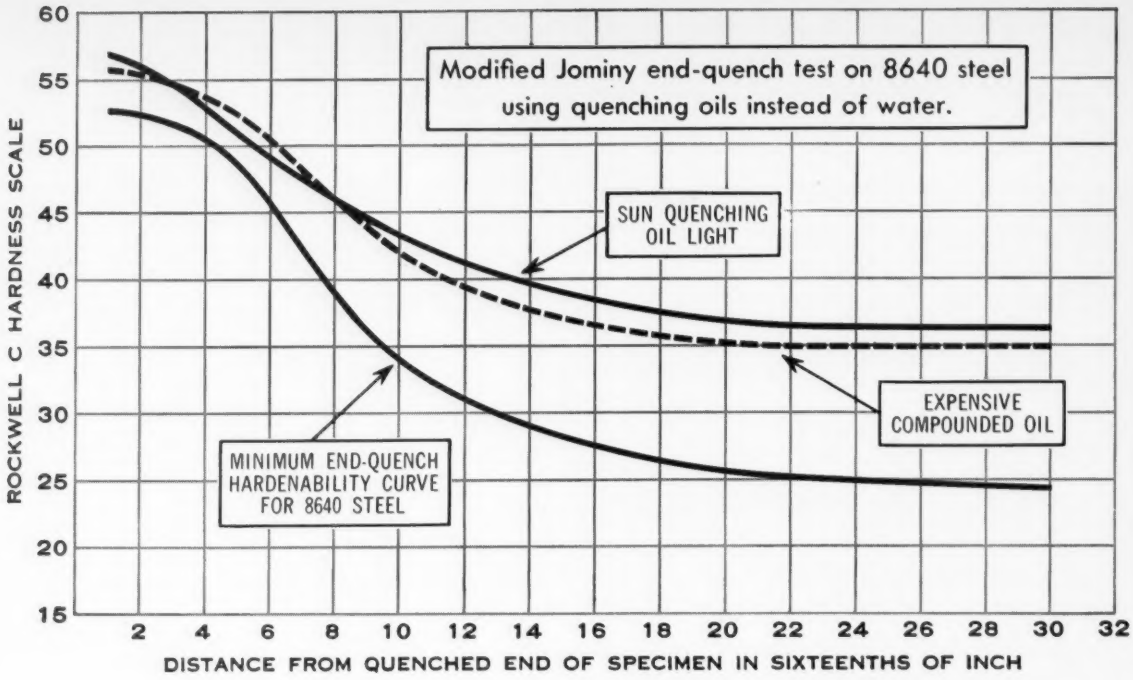
Hot Oil Quench system—provides exceptional distortion control. Large gas fired immersion tubes supply heat at low intensity thus minimizing oil breakdown.

Slow Cool Chamber permits cooling of a full furnace load in atmosphere and reloading without loss of time.

Delivery 8 to 10 weeks depending upon orders on hand.

DOW FURNACE COMPANY

12045 WOODBINE • DETROIT 28, MICH.



You can do 95% of all quenching jobs by using SUN QUENCHING OILS

This has been proved again and again in industrial heat treating departments and in the laboratory. The above test curves compare the results obtained from Sun Quenching Oil Light and those from an expensive compounded quenching oil. The hardnesses obtained are far above the commonly accepted minimum.

In addition to assuring consistently uniform physical characteristics, Sun Quenching Oils prevent sludge formation and help remove any deposits that may exist. Oil coolers are kept clean; maintenance costs are decreased. Sun Quenching Oils lower operating costs too. They thin out when heated, drain off parts faster and more completely. Make-up is materially reduced.

For more information about Sun Quenching Oils and how they can help you, call your nearest Sun office or write SUN OIL COMPANY, Philadelphia 3, Pa., Dept. MR-5.

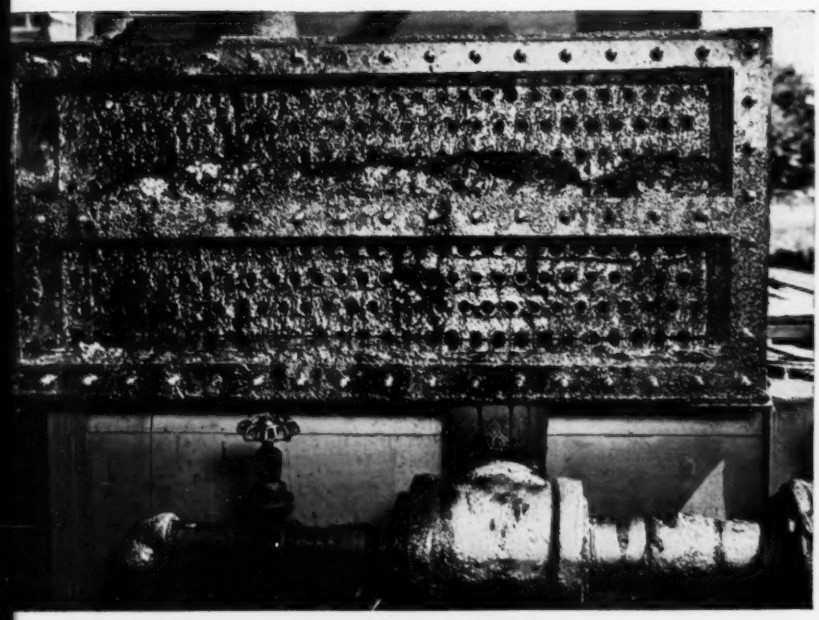
INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

SUNOCO®

PHILADELPHIA 3, PA. ◆ SUN OIL COMPANY LTD., TORONTO & MONTREAL

THIS PLANT QUENCHES ALL TYPES and sizes of automotive and aircraft forgings. Sun Quenching Oil Light serves all five of the 2400-3000 gallon systems. In the seven years the shop has been using this oil, no unit has been down except for normal mill scale removal.



AN OIL THAT FORMS SLUDGE CLOGS oil coolers, increases maintenance and operating costs. Sun Quenching Oils have a natural detergency which helps keep the systems clean and removes any deposits that may exist.

INDUSTRIAL PRODUCTS DEPARTMENT
SUN OIL COMPANY

SUNOCO

PHILADELPHIA 3, PA. ◆ SUN OIL COMPANY LTD., TORONTO & MONTREAL

Heat Treating Hints (cont.)

The die at right was a second attempt, incorporating fillets at the two corners instead of the unnecessary sharp corners. However, this die was quenched without any packing in the holes and cracking occurred between the holes. If the holes had been packed before the quench, there's a good chance the die wouldn't have cracked in the quench even though it was not tempered. The holes in these dies are for dowel pins and bolts, and there is no need to harden the internal surfaces; these should have been packed.

However, the cracking of both dies was due primarily to the omission of a temper following quenching. A certain percentage of most tools will crack if they are not tempered, regardless of the tool design.

It is possible to harden dies of both designs successfully — with the sharp corners and without packing the holes—if proper precautions are followed. But, if usual precautions are ignored, such hazards as sharp corners and unpacked holes will greatly increase the chances of cracking during treatment.

From "The Tool Steel Trouble-Shooter" Bethlehem Steel Company

Multiple Forms Provide Internal Control (cont.)

parts through the plant and are returned with the work to the inspection department and then to the original section area.

The heat treat checker removes the last two sheets of the form (#8 & 9) previously filed and places them with the work making certain the entire order is in place. These last two sheets of the form, packing slip and delivery receipt, go with the shipment.

The heat treat checker then turns in the factory instruction sheets for pricing. Upon completion of the pricing they are returned to the accounting department and billing is completed on the first three copies (invoices). Copies 1 & 2 are sent to the customer and copy #3 is posted under accounts receivable. All factory sheets are then filed by heat treat number.

Impregnation of Metal Castings

A new system for sealing porous castings has been developed by the American Metaseal Manufacturing Corp., 30 East 60th St., N. Y. The heart of the new system is a self-contained unit comprising autoclaves, high vacuum pump, thermostatically controlled wash tanks, a mechanical surging unit and a power operated hoist. Exclusive of the baking oven, the unit occupies approximately forty square feet of floor space. Used with Metaseal 19V5 resin, it is possible to achieve 100% filling of micropores in metal castings with successful results.

The new machine is built around a center hub unit which mechanizes all functions of the unit. Castings are run in batch loads without individual part handling in the process. All valves and switches for the machine are functionally mounted for accessibility.

Extinguisher for Oil Fires

A spray-type foam maker, designed to blanket flames with air foam over a wide area, has been developed by Pyrene Manufacturing Company, 560 Belmont Ave., Newark 8, N. J. for overhead protection of medium-sized oil and chemical hazards.

The foam maker is equipped with a cone shaped spray head which discharges an even pattern. The device is for use in fixed systems, singly or in multiples.

The foam spray unit should be located a minimum of four feet above the hazard to obtain full discharge coverage. Coverage ranges from ten to twenty feet in diameter depending upon operating pressure. A mixture of water and foam compound is supplied to the foam maker under a pressure of 30 psi or more. Foam is formed mechanically, expanding about eight times its original volume and sprayed in a circular pattern. Foam can be introduced into the main water line to the foam makers by a proportioning tank, around-the-pump proportioner or pressure line inductor. Portable playpipes, supplied through the same lines, can be used to augment the fixed system.

(Continued on page 35)

In one application the instantaneous determination of the temperature and the maintenance of the desired temperature with the Milliscope made it possible to double the output of a continuous conveyor furnace. In this case a Milliscope instrument operated

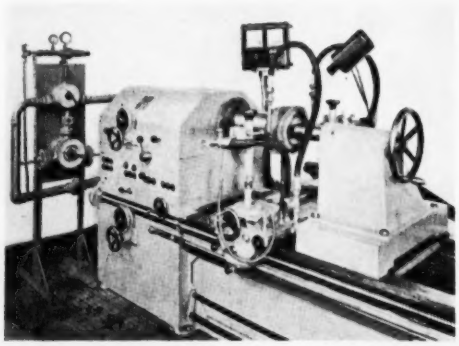


Fig. 6—Automatic machine for hardening shafts. Milliscope focused on work piece, controls mounted for easy visibility by the operator.

for a total of more than 15,000 hours without interruption and without loss of sensitivity.

This brief article has not covered applications for induction hardening but, of course, the Milliscope is equally suited to either induction or flame hardening. The instrument was designed and built in Germany for use on flame hardening machines but it is expected that it will find many applications in this country in the near future.

Heat Treating Carbon-Graphite Parts in Double End Batch Furnaces

Heat treatments, involving long cycles and volume production such as those required for carbon-graphite parts pose devious problems of material handling, accurate control of heat cycles and most effective load pattern, if small parts are involved.

For example, the handling of closely packed charges, requiring cycles of long duration, is readily adaptable to the batch-type or in-and-out box furnace. But here the problem is encountered of multiple handling of the containers and efficient utilization of hearth space. The containers to the rear of a single door furnace must be moved across the entire length of the hearth and then only after the forward charges have been removed.

Similar handling and produc tion problems were encountered by the United States Graphite Company, Division The Wickes Corporation, Saginaw, Michigan; manufacturer of a complete line of carbon and graphite parts for electrical and other requirements. To overcome these difficulties, a battery of ten Surface Combustion double-end oven furnaces has been installed.

To facilitate production, the material being treated is handled on transfer cars during all movements up to and away from the furnaces. Within the furnace, all charging and discharging is carried out simultaneously from both ends. This procedure speeds up handling, and by minimizing the number and extent of charge movements, reduces wear on furnace hearth plates.

Continuous automatic maintenance of the critical rate of temperature increase required for treatment warranted special consideration in setting up control procedures and equipment. A gradually changing heating rate and an accurate cooling speed had to be maintained over a time cycle of considerable duration.

To accomplish this delicate control, continuous chart recording and indicating controllers (0°F. to 2100°F.) are utilized. One set of instruments for each furnace is mounted on individual panels grouped at a central location in an adjoining room. Each panel contains either a strip or sheet type recorder and a heating rate interrupter operating from a cam-type program controller. This cam, cut for the complete heating and cooling curve is constantly motor driven. A cam follower, by synchronizing the controller interrupter with cam movement, off-on controls a butterfly valve in the air line manifold. This air line furnishes combustion air at 1 lb. pressure from individual turbo compressors to the low pressure burners on each furnace.

The one-valve control, automatic proportioning feature of this gas-burning equipment readily adapts it to off-on type control. Air under pressure acts as the inspirating or entraining medium for gas at zero pressure, and automatically regulates the gas required for constant, correct fuel-air ratio. By shutting off the air, the heat input is interrupted for the required period of time.

Products of combustion are not deleterious, consequently the furnaces are direct-fired. Two banks of burners are located in each side wall with one firing over the hearth at an angle and the other bank firing under it between the pier supports. Burners in opposing banks are positioned alternately for even heat distribution.

At a predetermined point in the cooling curve, the doors at both ends of the furnace are opened and a portable fan moved into position which forces room air through the furnace. Thus the final stages of the cooling cycle are accelerated and overall cooling time reduced.

NATURE SELDOM packs a perfect package. If a man is handsome, he often has the mind of an ape; and a woman fit to sit among intellectual giants is likely to have legs like stovepipes.

IN A SMALL BOOK called "Fun on the 5:15," Osborn Fort who works for a bank in New York City and commutes to a suburb, writes affectionately of railroad conductors, the men who punch and collect tickets.

Fort describes certain passengers as hippocket-titans. They are as bad as certain handbag females.

What follows will displease some readers.

Why should a man pack a billfold with everything from a birth certificate to a commutation ticket, and why should a woman fill her bag with six used handkerchiefs, plus house keys and her railroad ticket?

These people have a place for everything but don't know the place. They usually carry $100 to $300 in their billfolds and handbags, but they can't get at the money at the time the waiter presents the check for dinner. The man who carries his money loose and knows where it is, puts a hand in a pocket and pays. The operation is costly but it saves embarrassment.

Two Salem Gas Annealing Furnaces—Model 501

1 H.P. Induction Motor drives metal conveyor 21" wide with electric control panels. Each unit occupies a space 7½ ft. wide x 26 ft. long. Capacity—3,475,000 BTU or 3,000 cu. ft. per hr. Each unit is connected to conveyor 13½" wide x 10 ft. long. Excellent condition. Priced to sell.

Contact: W. Furlong, Gibson Mfg. Corp., Longmont, Colorado.

Manufacturers' Literature . . .

The literature listed below contains information of interest to heat treating organizations. For your copy write direct to the manufacturer and be sure you mention seeing it reviewed in "Metal Treating."

PICKLING

Bulletin No. 13 entitled, "Efficient Pickling With Rodine" is now available in the 1952 edition from American Chemical Paint Co., Ambler, Pa. The 80-page booklet covers the pickling process in detail as well as the effects of Rodine in a pickling bath. Part V of the booklet offers suggested practices for the pickling of various products, including forgings, castings and machined parts, to name a few.

• • •

HEAT RESISTANT ALLOY CASTINGS

A 48-page illustrated booklet entitled "Heat Resistant and Corrosion Resistant Alloy Castings in Industry" has been published by the International Nickel Company, Inc., New York 5, N. Y. Typical compositions, applications and service limitations of alloy castings are discussed. Approximately twenty pages of the booklet are devoted to data on heat resistant castings and illustrations of typical applications.

• • •

TEMPERATURE CONTROLS

The Burling Instrument Company of South Orange, N. J. has announced publication of catalog G-18. Included are descriptions of all Burling electric temperature controls, pictures of all models and a separate description of the company's pneumatic and valve type controls. The condensed catalog will be supplemented during the year with individual specification sheets, covering the various models in greater detail.

• • •

NEW TELEMETERING BOOKLET

A new booklet on telemetering has been published by The Bristol Company, Waterbury 20, Conn. Bulletin M1710 offers information on the use of the company's Metameter telemeter for remote measurement and automatic control of variables over distances ranging from a few feet to many miles. Bristol Electric Dynamaster transmitters and receivers are described and information is given on various methods of transmission. Among the applications shown are the remote measurement and control of temperatures, pressures, rates of flow, and various electrical quantities.

FLOW RATE INDICATORS

Bulletin No. 201 has been published by Waukee Engineering Company, 759 N. Milwaukee St., Milwaukee, Wis., covering a new line of Flo-meters for the indication of flow rates of air and industrial gases. The bulletin illustrates several installations of Flo-meters as single units and also as mounted on panels. Other data included are a cutaway drawing, selector chart and dimensions of available units.

• • •

LIGHTWEIGHT MATERIALS HANDLING EQUIPMENT

A new catalogue on lightweight materials handling equipment has been released by Tobey Manufacturing Corp., 1221 El Segundo Blvd., El Segundo, Calif. It covers the complete line of Tobey Materials handling trucks which are constructed entirely of aluminum and thus much lighter than conventional trucks. One truck manufactured by Tobey weighs only fifty-seven pounds but has a load capacity of two thousand pounds. A-frames, tote boxes, work tables and stack racks are also included in the catalogue.

• • •

FLAME BURNERS

Selas Corporation of America, Philadelphia 34, Pa., has published bulletin SC-1001 describing the Selas Spear Flame Burner, manufactured in five sizes. Of special interest are the full size illustrations of the burners and the flame length produced by them, together with BTU capacity, port area and full dimensions. A list of various recommended uses is included.

• • •

CONTINUOUS ROLLER HEARTH FURNACES

A new illustrated bulletin on roller hearth furnaces has been released by Surface Combustion Corp., Toledo 1, Ohio. Featuring the three principal design types—controlled atmosphere, direct-fired, convection heated, bulletin SC-160 describes typical process applications in both ferrous and non-ferrous fields. Related prepared gas atmosphere generators are shown and a handy chart of prepared atmosphere compositions is included for reference.

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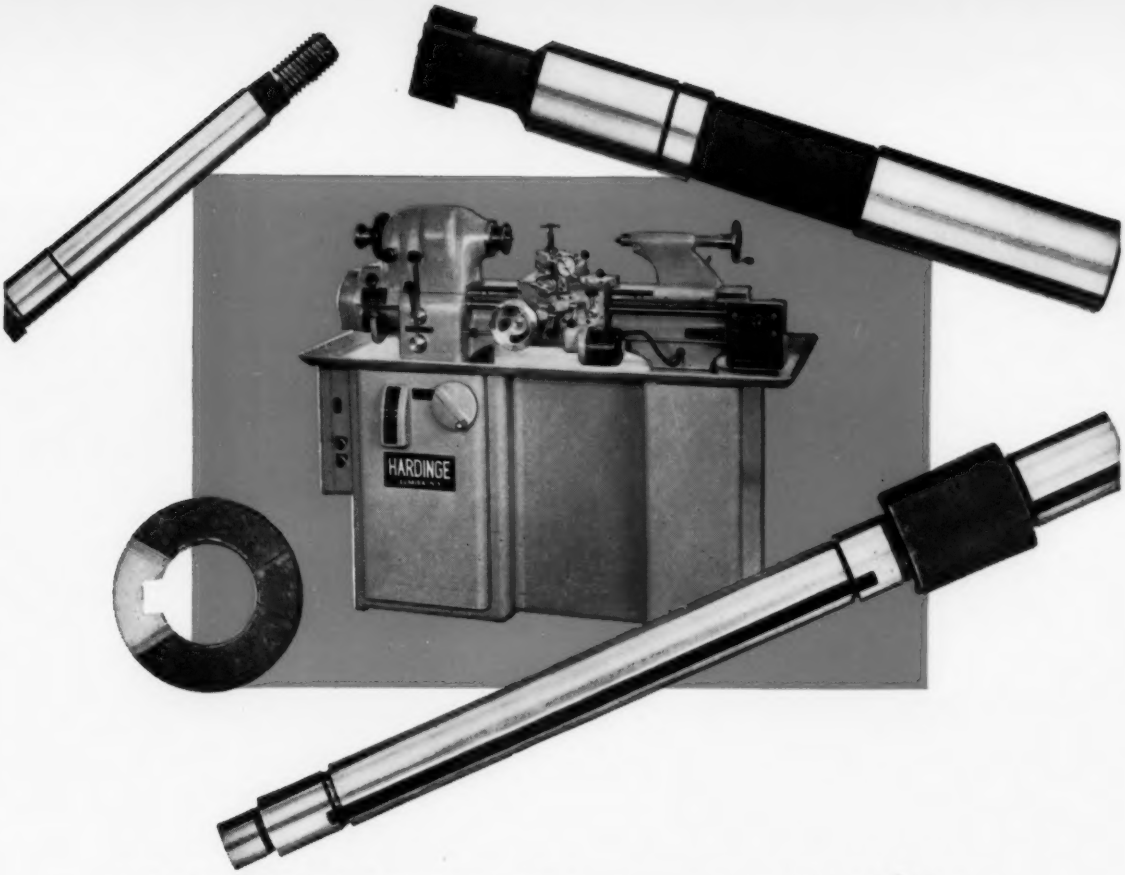

HARDINGE BROTHERS, INC., uses AEROHEAT® 1200 for uniform heat treatment, minimum distortion, plus extraordinary pot life!

Hardinge Brothers, Inc., Elmira, N. Y., uses AEROHEAT 1200 for precision heat treatment of many parts of the new model HARDINGE HLV High Speed Precision Tool Room Lathe.

Cluster shafts and reversing clutches—of AISI TS 8620 steel—are pack carburized at 1620°F to a case depth of 0.040 - 0.045 inches, cooled to below 600°F, reheated in AEROHEAT 1200 at 1460°F, oil quenched and tempered at 360°F to 61-63 Rockwell C.

Clutch shafts and speed selector shafts—in the same steel—are heated to 1460°F in AEROHEAT 1200, oil quenched and tempered at 1200°F to 28-31 Rockwell C.

AEROHEAT 1200 readily gives these parts the desired physical properties on lot after lot, with distortion at a minimum. The most striking result of using AEROHEAT 1200 has been the great increase in pot life. By using *welded*, special alloy gas-fired pots for AEROHEAT 1200, pot life has been increased to *12 months or more!* This unusual achievement with a neutral type heat treating salt is even more remarkable, since the AEROHEAT 1200 salt baths are operated six days a week and permitted to solidify on the seventh!

Cyanamid's heat treating compounds include:
AEROCARB® Carburizing Compounds
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AEROBRITE* Metal Processing Aid
Calcium Cyanamide 6-16
Metallic Stearates
Surface Active Agents
Acids and other Heavy Chemicals
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Get the complete story on AEROHEAT 1200 heat treating compound.

MT5

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INDUSTRIAL CHEMICALS DIVISION
30 Rockefeller Plaza, New York 20, N. Y.

☐ Send technical data sheet on AEROHEAT® 1200
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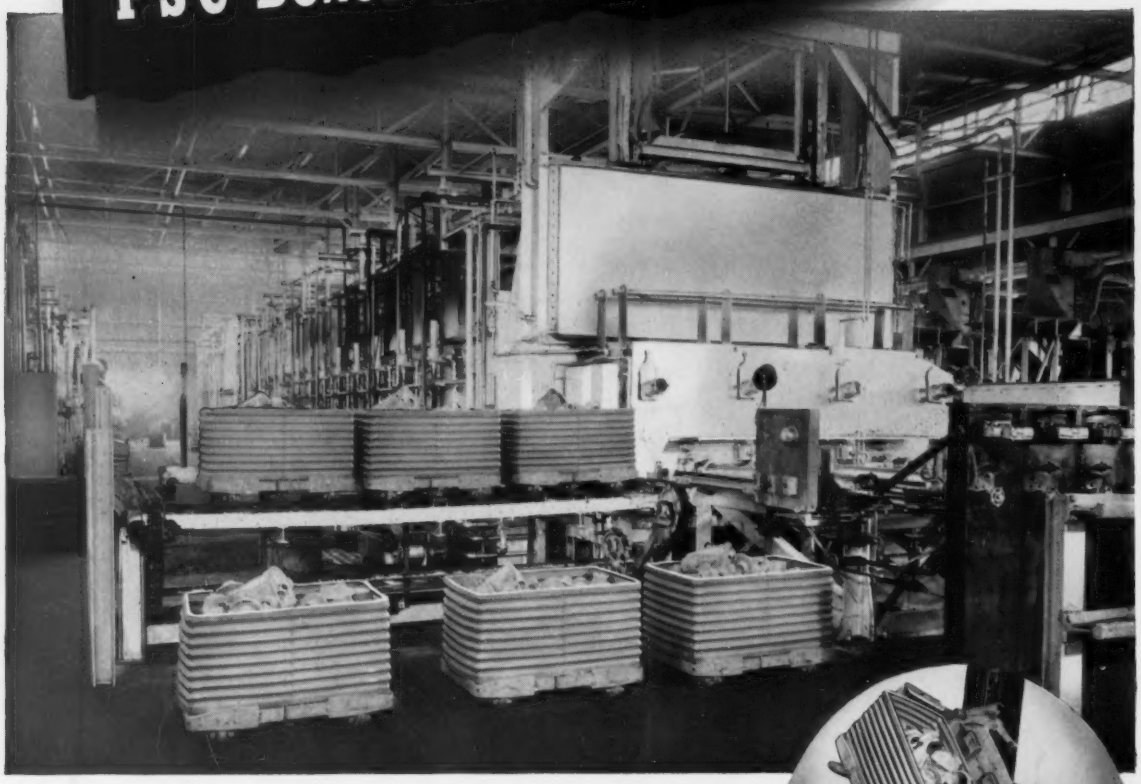
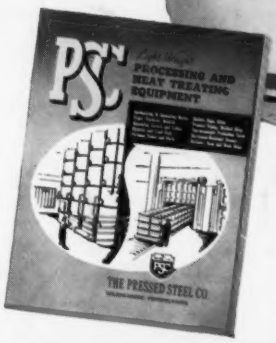
'Albion Malleable Iron' Chooses PSC Boxes for Huge Furnace



PSC Light-Weight Boxes Speed 800-lb. Loads for 120-ft. Long "Surface" Furnace

The above annealing furnace of Albion Malleable Iron Co., Albion, Mich., is one of the longest ever built by Surface Combustion Corp. It's 120 ft. long, and 11½ ft. wide inside. To effect ready flow of work to and from the great furnace, PSC "light weight" boxes were adopted and then designed for use with both roller trays and lift trucks, as pictured. As pioneers of light-weight, sheet alloy, heat-treating containers, we make available to you a wealth of production know-how. PSC furnishes equipment in any size and for any product. Send blue prints or write as to your needs.



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